Calcutta University Jubilee Research Prize

CHEAP BALANCED DIETS

(FOR BENGALIS)

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BY

NISHIKANTA RAY, B.A.

BACTERIOLOGIST, PUBLIC HEALTH DEPARTMENT, BENGAL

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PREFACE

Food is the foundation and mainstay of life. Experience has shown that a well-balanced diet is essential in building up and maintaining a good physique and sound health and in increasing the stamina and longevity, and a properly fed and well-nourished body has extraordinary powers of resistance to infections by germs. Some people are not lucky enough to inherit good constitutions from their parents. Although inheritance must set definite limits to the possibilities before each individual, his native endowments are permitted to develop and function to the greatest advantage through the best possible state of nutrition. Consistent adherence to a deficient, ill-balanced dietary (especially in the growing period of one's life) is the most potent cause of poor physical development, general ill-health, lack of stamina and short life, and the ravages of infectious diseases are especially severe amongst those whose resistance has been impaired by defective nutrition. It is becoming more and more widely recognised that adequate nutrition and efficient sanitation are factors of outstanding importance in promoting the physical efficiency and well-being of the people and in diminishing the probability of infectious diseases.

Our knowledge of the dietary requirements is the product of careful investigations carried out in many parts of the world by means of feeding experiments upon man and lower animals. The dietary values of the common food materials have been studied jointly by chemists, physiologists and dietetists. Unless the dietary needs of the body and the dietary values and prices of the different food materials are known, we are not in a position to determine the extent to which one food may be used as a substitute for another in the planning of dietaries with a view to combining economy, nutritional efficiency and the gratification of the individual taste. This thesis is therefore divided into four chapters: Chapter I deals with the dietary constituents and their contribution to nutrition; Chapter II discusses the quantitative food requirements; Chapter III summarises the dietary value of the principal foodstuffs; and Chapter IV is devoted to the planning of cheap balanced dietaries to satisfy the physiological needs of the individual at different ages, and in the case of women, during pregnancy and lactation, and shows incidentally how far in practice we fall short of the ideal and what practical steps we must take to set right the dietary deficiency or to improve the dietary.

It will be seen that a well-balanced diet for a Bengali adult man can be devised at costs (at retail rates at Calcutta) varying from Rs. 4-12-0 to 5-12-0 per month according as he is engaged in sedentary pursuits or performs moderate physical work. In smaller towns and villages the diet can be arranged more cheaply. It is hardly too much to say that as the general public are educated in the principles of dietetics, the money available for food will be properly spent so as to get the largest return in food value, and progressive changes in the traditional dietary habits will be brought about. The possibility of improving nutrition by purely educational means is, however, limited, as large numbers of our people, even though they may have adequate knowledge of dietetic principles, have not the requisite means to provide adequate diets. In fact, no substantial improvement in the present nutritional status of the masses can be expected unless their purchasing power is raised partly through increase of individual income and partly through a reduction of food-prices. When the price of foodstuffs is high and the income is low, the consumer is forced to abandon the purchase of the more expensive and dietetically valuable foods (such as milk, eggs, fruits, etc.) in favour of those which satisfy at the lowest price the immediate claims of his hunger ; even when his income remains unchanged but the price is reduced, he is induced to purchase such foods as will provide diets of increasing nutritive value. It is generally held that the price of foods could be much reduced by increasing their production on the one hand, and by improving and cheapening their marketing and distribution on the other.

Expert opinion unanimously holds that there are immense possibilities of increasing our food supplies by utilising the available food resources of the country in the best possible manner. The out-put of any crop from a given area of land can be enormously increased by adopting up-to-date methods of farming which involve good cultivation of the soil so as to make it a physically efficient medium for the growth of plants, application of adequate amount of water and manure (supplying the food materials which the plants require for full development) and the introduction of the best and most productive varieties of the particular crop grown. The existing crop-producing areas will also have to be enlarged by bringing under cultivation the total cultivable area. The production of milk can be increased manifold by improving the milk-producing capacity of cattle through proper feeding and management and careful breeding. In the breeding of milch cattle, it should be remembered that a high-milking cow is likely to transmit the high milk-producing quality to her female offspring, and a bull which has a high-milking mother and whose sire is the son of a high-milking dam will generally impart a high milk-producing capacity to his daughters. In fact, the milk supply of a cow depends upon the productive capacity she inherits from the dam and the sire. As a bull is capable of siring some 75 calves in a year, whereas a cow can produce one calf at most in a year, cows of improved milk-producing capacity are bred more quickly through superior bulls than through superior cows. The capacity of hens and ducks for egg-production is also a definitely inherited character. If these birds are bred by employing, as parental individuals, heavy layers and the male progeny of high egg-producing stocks, and are given the right kind of treatment and good wholesome food, they will prove prolific layers, and the supply of eggs can thus be multiplied almost as many times as we may desire. The fish supply is capable of indefinite expansion on the one hand by the rearing of different varieties of fish in perennial water tanks and on the other by actively exploiting the estuarine and sea-fisheries. It may be noted that the sea is the largest repository of piscine wealth and the estuaries are amply replenished from the sea, and an inexhaustible supply of fish can be obtained from these sources provided there are expert fishermen, sea-worthy vessels and suitable appliances for capture. Capital and enterprise are essential to work these valuable fisheries. Adequate facilities must also be provided for quick transport of the catches from the fishing grounds to the different distributing centres and cold storage not only on steamers and trains but also at the markets so that fish may be brought from long distances and preserved for a reasonable time until they are required.

The bulk of the population of Bengal, as elsewhere in India, depends upon agriculture for their livelihood. The work of the peasantry on their lands is however intermittent, and there is usually a good deal of spare time much of which can be devoted to dairying, poultry-farming and the like. What is imperatively needed is to give the cultivators the opportunity of learning how improvements in different branches of food production can be introduced and to encourage them to effect these improvements. There is every reason to hope that the general adoption of modern scientific methods of food production will result in a greatly increased out-put of all classes of foodstuffs to the benefit of both the producer and the public at large—the producer will get a higer return for the labour and capital employed and will thus be in a position to improve the family diet and to enhance his income by selling the surplus of foods, while the consuming public will be ensured of a sufficient supply of foods at the lowest price consistent with the adequate remuneration of the producer and the distributor.

N. K. RAY.

CHAPTER I

DIETARY CONSTITUENTS AND THEIR CONTRIBUTION TO NUTRITION

The various food-stuffs constituting the diet supply us with six different substances—proteins, carbohydrates, fats, mineral salts, water and vitamins. All of these are necessary in proper amounts in the diet for normal nutrition.

Proteins.—Their chief rôle in the body is to provide materials not only for repairing the wear and tear that takes place in the tissues as a result of the functioning of the body, but also for building up new proteins in the bodies of growing individuals. They are also the sources of many enzymes (such as those concerned in the digestive processes) and hormones (*e.g.*, thyroxine, adrenaline, etc.) which are needed for speeding up of chemical processes of the body. The surplus proteins, after these needs have been satisfied, may be utilized for the generation of energy, but this is an uneconomical and unnatural method.

There are many kinds of proteins—*e.g.*, casein (the chief protein of milk), myosin (of meat and fish), ovalbumin and ovo-vitellin (of egg-white and egg-yolk respectively), globulin or legumin (of dals or pulses), glutenin and gliadin (of wheat), etc. The proteins are found in most natural food-stuffs in varying amounts but their main sources are milk, eggs, meat, fish and dals. Each of these and most protein-containing foods contain a mixture of different kinds of proteins. Biologically, a protein is a mixture of various amino acids.[1] Before the average protein can be utilized by the body, it must undergo digestion, that is to say, it must be split into the component amino acids by the action of different enzymes which are secreted into the stomach and the small intestine. The amino acids are next absorbed into the blood and conveyed to the various active tissues of the body where they are re-combined into the proteins of the body and utilized as structural materials for the repair of the wear and tear of the tissues and for the formation of new tissues as in growth. The great bulk of the ingested amino acids are, however, de-aminized. The amino group is converted into urea which is excreted in the urine; the non-nitrogenous residue left after de-aminization undergoes various changes and its energy is eventually liberated by its complete oxidation. Under appropriate experimental conditions, the de-aminized residue may be converted into glucose which may ultimately be turned into fat. In actual fact, however, the protein of the food does not usually give rise to fat in the body

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[1] Twenty-two different kinds of amino acids are known.

The nutritive value of a protein is the resultant of two factors, namely, the proportion which gains access to the organism as a result of the digestive process and the proportion of the materials thus taken in which is actually used by the body in satisfying its needs (*e.g.*, in building up the tissues and in making good the wear and tear). The capacity of a protein to satisfy the needs of the body is dependent upon the kinds and quantities of amino acids it contains. It is interesting to note that some of the amino acids can be formed in the body by the combination of the appropriate fatty acid groupings (which result from carbohydrate metabolism) and part of the ammonia set free by protein disintegration. But the body is incapable of synthesising certain of the amino acids owing to the fact that the means is wanting for the manufacture of some of the radicals which form the non-nitrogenous part of the amino acid. We know, for example, that definite quantities of lysine, cystine, tyrosine, tryptophane (which may be replaced by phenyl alanine) and histidine must pre-exist in the protein of the diet if normal health and growth are to be maintained. Each of these amino acids plays a special rôle in the process of nutrition. Lysine and histidine are essential for growth, and growth takes place more rapidly if cystine also is provided. Tyrosine is very important because thyroxine and adrenaline are probably derived from it. Tryptophane is essential for life and for the maintenance of body weight. Whatever be the source, a protein lacking in one or more of these nutritionally essential amino acids is, when taken by itself, is a deficient protein from the nutritional point of view. The more closely the amino-acid make-up of an isolated protein or a mixture of proteins in a particular food-stuff resembles that of our bodily tissues, the greater is its biological value.[1] Proteins which have a low biological value by themselves (on account of the fact that they do not contain the amino acids in proper quantities) may easily have a high biological value when they are fed in combination with other proteins, since they may supplement each other by correcting the amino acid composition of the protein foods (*e.g.*, by furnishing the essential amino acids or toning down a large preponderance of one or more of the essential amino acids which are required only in small proportions) and thus bringing the supply as far as possible into line with the demand. The following table shows the percentage of proteins in some common food-stuffs and the digestibility and biological value of the protein contents[2] :—

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[1] The biological value represents the percentage of the digested proteins which is utilized to replace tissue waste. For instance, if 100 parts of food-protein nitrogen can replace 100 parts of body-protein nitrogen, then that protein of the food is said to have a biological value of 100 per cent.; if, however, 100 parts of the food-protein nitrogen replace, say, 60 parts of body-protein nitrogen, then the biological value of the protein of the food is only 60 per cent.

[2] References: (1) Terroine, E. F.—"The protein component in the human diet," Bulletin of the Health Organisation, League of Nations, September, 1936. (2) Basu, K. P., Nath, M. C., and Mukherjee, R.—"Biological value of the proteins of soya bean, field pea and lathyrus

Foodstuffs	Protein (per cent.)	Digestibility (per cent.)	Biological value (per cent.)
Rice, raw, milled	6·8	97	80-87
Whole wheat	11·8	91	67
Wheat flour	11·0	100	52
Milk (cow's)	3·3	100	85-100
Egg (whole)	13·3	100	94
Beef, muscle	22·6	87-98	95-104
Fish (average)	17·0	90-98	80-94
Dals—			
Arhar dal	21·7	75	72
Chola dal	19·9	86	62
Khensari dal	28·2	88-91	44-50
Masur dal	25·5	88	41
Mug dal	24·4	86	51
Matar dal	19·7	87-92	41-48
Mashkalai dal	22·5	78	62
Soya bean	43·2	83-94	47-64
Potato	1·8	78	67

From the above table the net protein value of the food can be calculated. Rice, for instance, contains 6·8 per cent. of proteins, of which 97 per cent. is digestible;

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sativa," Indian Journal of Medical Research, April, 1937. (3) Swaminathan, M.—" The relative value of the proteins of certain food-stuffs in nutrition," Parts I-III, Indian Journal of Medical Research, January, July and October, 1937. (4) Mitchell and Hamilton—" The bio-chemistry of amino acids," Chemical Catalog Co., p. 556. (5) Cathcart, E. P.—" Nutrition and Dietetics." (6) Basu, K. P. and De, H. N.—" Nutritional investigation of some species of Bengal fish," Indian Journal of Medical Research, July, 1938.

it, therefore, contains 6·5 per cent. of digestible proteins. If 80 per cent. of the digestible proteins of rice is used to satisfy the protein requirements of the body, it contains 5·2 per cent. of net proteins available for utilization by the body, the remaining portions being wasted. Similarly, wheat flour contains 5·7 per cent. of available proteins. Obviously, the quality of the proteins should be taken into consideration as well as the quantity in planning the diets. It is, however, important to remember that the differences of the biological values which have been noted for the proteins of various foods considered separately are divested of much of their importance by the operation of the process of supplementing. The nutritive value of medium or low quality proteins is generally enhanced when they are taken with high quality proteins. A striking example of this is to be found in the fact that when a mixture of wheat flour and beef, in proportion of two parts of wheat flour proteins and one part of beef proteins, is fed together, the combination is practically as efficient as three parts of beef proteins alone.[1] In fact, meat, fish, egg and milk contain proteins which are highly efficient in supplementing the nutritional shortcomings found in some of the vegetable proteins. The great importance, both nutritionally and economically, of drawing the proteins in our diets from vegetable and animal sources must be emphasised, since the low-priced proteins of cereal grains and pulses and other vegetable foods are greatly improved in quality and may even be raised to the level of the high quality proteins such as exist in milk, meat, etc.

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[1] Terroine, E. F.—"The Protein Component in the Human Diet," Bulletin of the Health Organisation, League of Nations, September, 1936.

Carbohydrates.—They are needed by the body for the production of heat to maintain its temperature and of energy for the internal and external work of the body.

The carbohydrates form the great bulk of the average diet and are consumed in the forms of mono-saccharides, di-saccharides and poly-saccharides. There are three of the mono-saccharides which are of importance from a physiological standpoint—*viz* , glucose (the chief constituent of the sugar of fruits, especially grapes), fructose (which occurs mixed with glucose in honey and in ripe fruits) and galactose (formed by the digestion of lactose of milk). There are also three di-saccharides of physiological importance—they are saccharose or cane sugar (which is found in sugar cane, sweet fruits, etc.), lactose (a constituent of milk) and maltose (which is the sugar in germinating barley or malt and is also formed during the digestion of starch). The poly-saccharides include starch (which constitutes the bulk of the carbohydrate in our diet, being present in large quantities in nearly all vegetable food-stuffs and is a prominent constituent of rice wheat, sago, tapioca, barley and potato), glycogen (found in the liver, muscles and other tissues of the body), dextrins (which are intermediate products obtained in the transformation of starch into maltose) and cellulose (*i.e.*, the coarse fibres of whole cereal grains, pulses, vegetables and fruits).

In the process of digestion, the di-saccharides and starch are converted into mono-saccharides (for instance, maltose and starch are converted into glucose, lactose into glucose and galactose, and cane sugar into glucose and fructose). These are absorbed into the portal vein and carrried to the liver. Galactose and fructose may there be converted into glucose. Most of the glucose is then transformed into glycogen and stored in the liver and muscles, to be gradually liberated when required, furnishing heat and energy by oxidation. Some of the absorbed sugar is also converted into fat and is stored in this form. Cellulose is not digested in the human body and is, therefore, without value from the view-point of actual nutriment ; but it promotes the evacuation of the bowels and is thus invaluable as a necessary part of the diet. In case of delayed evacuation of the bowels, which is the characteristic phenomenon associated with constipation, the bacteria (which even in health swarm in the intestinal tract) get a better chance of acting on many of the products of digestion and of producing a series of products which, when absorbed from the intestinal canal into the body, act as toxic or poisonous matter.

Fats.—Like carbohydrates, the fats are also heat- and energy-producing components of food-stuffs, but they act more slowly than carbohydrates. Besides supplying heat and energy to the body, they also repair and renew the fatty tissues, help in the proper utilization of other nutrients by promoting the flow of the pancreatic juice and bile and assist the excretory functions of the intestine.

Fats represent mixtures of various glycerides (that is to say, compounds of glycerol and various fatty acids, such as palmitic, stearic and other saturated acids, as well as unsaturated acids like oleic acid, linolic acid, etc.), in varying proportions, and may have different physiological values. The fatty substances which are liquid at the ordinary temperature are termed oils, and those that are solid, fats. During digestion, the oil or fat is broken down into glycerol and the constituent acids. Glycerol is absorbed as such, and the acids are absorbed partly in the form of acids and partly in the form of sodium or potassium salts. Very soon after absorption the acids and glycerol re-unite. to form a type of fat peculiar to the specific organism, and this neutral fat eventually reaches the blood. Part of it is next carried to the ordinary fat depôts like the adipose tissue and is there deposited as reserve fat so as to be mobilized when it is required for metabolic purposes, and the remaining part undergoes immediate metabolism and yields its store of energy.

Fats which are utilized as a component of diets are drawn from both vegetable and animal sources. In vegetable food materials they are found in largest amounts amongst the nuts and seeds from which they are expressed to make the vegetable fats or oils, such as cocoanut oil, mustard oil, etc. Fats of animal origin are available in the form of butter, ghee (clarified butter), fat of flesh, bone marrow, etc. It is important to remember that a fat which is fluid at the body temperature (about 37°C) is more easily digested than one which is more or less solid. The melting point of some common fats is given below:—

Nature of fat	Melting point °C
Cocoanut oil ...	21 to 24
Butter ...	28 to 33
Hog's fat (lard) ...	36 to 48
Ox marrow fat ...	37 to 45
Ox tallow ...	40 to 49
Sheep's tallow ...	44 to 52

Fats containing highly unsaturated fatty acids have, however, a greater inhibitory effect on gastric secretion than fats which contain more saturated fatty acids.[1] Milk fat is of low melting point as compared with most meat fats and contains only a small amount of unsaturated acids. In fact it is the most easily digestible of all fats and its value as an article of diet is enhanced by the fact that it is the most important source of vitamins

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[1] "The Extra Pharmacopoeia"—Martindale and Westcott, Vol. II, p. 364, 20th edition.

A and D among our staple food-stuffs. Cocoanut oil melts at a lower temperature than butter and contains a smaller amount of unsaturated acids. Mustard oil (liquid at the ordinary temparature) consists largely of the glycerides of oleic, erucic and other unsaturated acids. By subjecting the vegetable oils to the process of hydrogenation, they may be converted into fats resembling ghee in consistency owing to the conversion of unsaturated acids into saturated ones. Vegetable oils and fats (with the exception of red palm oil) are practically devoid of vitamins A and D.

Besides the ordinary fats, other fat-like substances form important components of living cells. These substances are grouped together under the title of the lipoids or lipins. They are present, to some extent, in the fat of the food and utilized in the formation of the lipoidal constituents of body tissues. Two well-marked groups of these bodies have been differentiated, *viz.*, the phospholipines or phosphatides and galactolipines or cerebrosides. The chief phospholipine is lecithin which contains, in addition to its fat nucleus, phosphoric acid and a basic nitrogen-containing substance called choline. It is probably employed, to the largest extent, in the building-up of the central nervous system, where it forms the most important constituent of the medullary sheaths of the nerve fibres. Egg-yolk contains about 10 per cent. of this phosphorised fat, and liver about 2 per cent.; about 3 per cent. of human milk protein and about 1·5 per cent. of the total proteins of cow's milk is lecithin. The galactolipines are compounds of a carbohydrate (galactose), fatty acids and an organic base called sphingosine, and are found mainly in brain and nervous tissues.

Mineral Salts.—The mineral constituents of the human body amount to about 4·4 per cent. Besides oxygen, hydrogen, carbon and nitrogen, the most important of the elements which are present in the body are sodium, potassium, calcium, magnesium, iron, manganese, copper, phosphorus, sulphur, chlorine and iodine. These various elements are found in the body either as oxides or as salts. As all of these substances are constantly leaving the body in the excretions, it is obvious that a sufficiency of these substances must always be available in drinking water and in food materials, for the normal structure and functioning of the body. Generally speaking, most of the mineral constituents are consumed with water and foods in adequate amounts, but the elements which are most likely to be deficient in ordinary diets are calcium, phosphorus, iron and sometimes iodine.

Calcium as well as phosphorus are needed in high proportions in the bones and teeth for their required degrees of permanence of form, of rigidity and hardness. They have also essential parts to play in the soft tissues and the body fluids as well. Calcium makes the heart work properly, makes the blood clot so that too much blood is not lost if our bodies are cut or wounded, and maintains the normal response of the nerves to stimulants, preventing their excessive excitability. The principal calcium-containing foodstuffs are milk, egg-yolk and green leafy vegetables of various kinds.

Phosphorus has other functions besides those in which it participates in combination with calcium. Every cell in the body contains phosphorus. It is the multiplication of these cells which enables the body to grow. Phosphorus is thus essential to the multiplication of the cells and the growth of the body. The following foodstuffs are rich in phosphorus—whole-wheat flour, home-pounded rice, dal, egg, fish, meat and liver.

Iron constitutes an exceedingly small fraction of the body's weight (the whole body of man containing only six grammes); yet it plays an exceedingly important part in the nutritional processes. Iron is an essential constituent of haemoglobin (the colouring matter of the red blood corpuscles) and enables this substance to absorb oxygen from the inspired air and carry it to every part of the body for vital functions. Fortunately, the daily loss of iron from the body is small, but it is essential that the stock should be replenished regularly by eating foods rich in iron. Insufficient ingestion or assimilation of iron leads to a diminished concentration of haemoglobin; consequently, the power of the blood to absorb oxygen for body requirements is reduced and a condition of anaemia results. Infants and adult women in the child-bearing period are particularly prone to suffering from anaemia. Iron enters the body chiefly in egg, meat, dal and the green leafy vegetables. The tables on pages 28-36 show the amounts of calcium, phosphorus and iron in the edible portion of the common foodstuffs in the condition in which they are ordinarily marketed.

The need of iodine for the normal functioning of the body has in recent times been strongly emphasised. The body requires only an infinitesimal quantity (less than one-tenth of a milligramme) of iodine. Yet it is essential for the formation of thyroxine, the active principle of the thyroid gland. Unless this substance be secreted in sufficient amount, a condition of goitre develops, characterised by a swelling of the thyroid gland in the neck and associated with a series of bodily changes and a dulling of the intellect; when secreted in an excessive amount, it over-stimulates the metabolism and induces a series of nervous and other changes.[1] When there is a shortage of iodine in the drinking water, or in the soil and hence in the vegetable food materials grown in it, the incidence of goitre is very high. It must also be remembered that even when the iodine intake is sufficient, the iodine absorption from the gut may be interfered with by bacterial action; continued ingestion of such bacteria in polluted water supplies might cause goitre in certain districts. The iodine content of foodstuffs varies with locality. Heavy cropping of the soil tends to deplete it of iodine. The iodine compounds are also being steadily washed away from the rocks and soils of the earth's surface and are finally finding their way into the sea which, therefore, constitutes the world's great iodine reservoir. Sea-fishes and the oil from their livers (*e.g.*, cod liver oil which contains 0·0002 to 0·04 per cent. of iodine in organic combinations) and vegetables and fruits grown near the sea-coast contain a lot of iodine. The nearer we get to the sea, the greater is the iodine content of the plant and animal foodstuffs and of the water that we consume. Green leafy vegetables and fruits contain, as a rule, enough iodine for our needs. Garlic is one of the richest among the vegetables in iodine, the amount being as high as 0·9 milligramme per kilogramme. Some of the condiments, such as cloves, ginger and black-pepper, are also rich in iodine.

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[1] "Nutrition and Dietetics"—E. P. Cathcart.

A point of very considerable importance is whether the mineral constituents are present in such proportions as to render the foodstuffs acidic or basic. Of the acid-forming elements, sulphur and phosphorus (occurring in proteins) are the most important, as they are converted into sulphuric acid and phosphoric acid in the course of protein metabolism. The most important alkali-forming elements are potassium, sodium, calcium and magnesium. The following table shows the percentage of acid-forming and alkali-forming elements in the edible portions of some of the common food-stuffs[1] :—

Food-stuffs		Acid-forming elements		Alkali-forming elements			
		Phosphorus	Sulphur	Potassium	Sodium	Calcium	Magnesium
Wheat, whole	...	0·315				0·054	
Rice, home-pounded	...	0·165				0·007	
Rice, milled	...	0·108	0·117	0·07	0·025	0·007	0·033
Peas, dried	...	0·298	0·219	0·903	0·104	0·068	0·149
Lentils, dried	...	0·250	0·277	0·877	0·062	0·130	0·101
Egg-white	...	0·015	0·216	0·160	0·156	0·013	0·010
Egg-yolk	...	0·592	0·166	0·115	0·075	0·130	0·016
Meat (average)	...	0·216	0·230	0·340	0·084	0·012	0·023
Fish (average)	...	0·300	0·224	0·334	0·077	0·090	0·025
Milk, cow's	...	0·090	0·034	0·143	0·051	0·120	0·012
Potato	...	0·034	0·03	0·429	0·021	0·004	0·028
Spinach	...	0·01	0·038	0·774	0·125	0·06	0·037
Cabbage	...	0·04	0·066	0·247	0·027	0·03	0·015
Banana	...	0·04	0·010	0·401	0·034	0·002	0·028
Tomato	...	0·018	0·014	0·275	0·01	0·008	0·010
Lemon juice	...	0·01	0·01	0·175	0·004	0·023	0·007

The foregoing table shows that rice, wheat, egg, meat and fish are rich in acid-producing elements and poor in alkali-producing ones whereas milk, vegetables and fruits are rich in alkali-producing elements and poor in acid-producing ones. If it be remembered that the body requires a faintly alkaline medium for metabolism, it is obvious that, unless undue strain is to be put on the organism, the food given in a mixed diet should tend towards the basic side. Rice has its corrective in milk and fish and meat in vegetables. Lemon juice, pickles and chutneys made of acid fruits promote an alkalinity of the blood, for during digestion the organic acids (such as citric, tartaric and malic acids of naturally acid foods) existing in combination with potassium, calcium, etc., are converted into carbonic acid, which then combines with the alkalies, forming carbonates and bicarbonates, and these (that is to say, the alkaline carbonates and bicarbonates) maintain the alkalinity of the blood.

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[1] Ref :—" Nutrition and Dietetics"—E. P. Cathcart, and the tables on pages 28-36.

Water.—Water, though not strictly speaking a food, is an essential part of the diet. It keeps the products of digestion in solution and transports them through the body to the point where they are required, flushes the waste products (which, otherwise, would accumulate and poison the system) out of the system and is of especial value in getting rid of the surplus heat from the body by the evaporation of sweat. Water forms some 70 per cent. of the body weight of man. This fact alone suggests its importance in other ways than those merely dietetic. A man can live for many weeks without food provided he has plenty of water, but life is only a matter of days without any water at all. A large amount of water is lost from the body in the urine, faeces, sweat, and breath. To make good this loss, an adult person should drink ordinarily about 60 to 80 ounces of water daily in addition to the amount obtained from different food substances. In Bengal, the water supplies are derived from springs, wells, tube wells, tanks, rivers and water courses (khals). The chief desiderata of potable water are (1) freedom from turbidity, colour and odour, (2) a high degree of purity with reference to all organic matter including disease-germs, (3) presence of a few grains only per gallon of mineral salts derived naturally from the earth's crust over which the water flows or through which it percolates, and (4) freedom from lead, copper or other objectionable metallic salts. What should be aimed at is to procure a supply of water sufficiently good to require no artificial purification. The majority of our water supplies are, however, unsuitable in their natural condition for drinking purposes and should be efficiently purified by filtration, sterilisation or other methods before it reaches the consumer.

Vitamins.—The vitamins are complex organic substances existing in minute quantities in certain food materials. They are essential for the correct utilisation of the other dietary components and for normal health, growth and even life, but we have no conception of the manner in which they exert their physiological effects.

The presence of several vitamins is now recognised, the principal ones being vitamins A, B_1, B_2, C, D, and E. Each of them plays a different rôle in nutrition. If they are inadequately supplied in the diet, whatever else there may be, nutrition flags. It is now becoming generally recognised that much subnormal health and development may be associated with a partial deficiency of one or more of the vitamins. The severe, prolonged deficiency of any one of them gives rise to a specific nutritional deficiency disease (often called avitaminosis). The tables on pages 28-36 give an idea of the importance of foods as sources of vitamins A, B_1. B_2, and C.

Vitamin A.—This vitamin is essential for proper growth and health. It is an unsaturated alcohol of the empirical formula $C_{20}H_{30}O$ and related to carotene, $C_{40}H_{56}$. Carotene is a yellow pigment which occurs in carrots and in many other vegetables. It also occurs in conjunction with (and hidden by) the green substance chlorophyll in leaves and other green parts of plants. When carotene is consumed in green vegetables, it is converted into vitamin A in the liver ($C_{40}H_{56} + 2H_2O = 2C_{20}H_{30}O$).

Principal Sources.—Amongst the most abundant sources of vitamin A or carotene are whole milk, milk fat (*e.g.*, butter), liver fat, fish liver oils (cod liver oil and halibut liver oil being very rich in vitamin A), egg, carrot, green leafy vegetables and some fruits, such as ripe mango, ripe papaya, and tomato. Betel leaves are particularly rich in carotene. Oils and fats of vegetable origin are in general devoid of carotene and vitamin A. Red palm oil is an exception. It is derived from the fruit of the palm elaeis guineensis and is very rich in carotene. In the tables on pages 28-36 the vitamin A and carotene contents of foodstuffs are expressed in terms of the International Units, the International Unit for vitamin A being defined as the vitamin A activity of 0·6 micro-gramme (1 micro-gramme being equivalent to 0·001 milligramme) of the International standard carotene.

Properties.—Vitamin A is soluble in fats and is relatively stable. In the absence of air or oxygen, it will stand heating to a high temperature (say, about 200°C), but heating in presence of air (for instance, when food materials are fried or boiled over strong fire in an open pan) destroys this vitamin. Ordinary cooking does not destroy the carotene present in vegetables.

Effect of Absence from Diet.—In the absence of vitamin A, animals cease to put on weight, the resistance of certain areas (*e.g.*, eyes, lungs and intestines) to infection is reduced, and the characteristic inflammation of the eyes called xerophthalmia, broncho-pneumonia and enteritis may develop.

Vitamin B_1.—This vitamin also is necessary for promoting growth and has an important relation to health at all ages. It is a crystalline basic substance containing sulphur. The empirical formula is generally accepted as $C_{12}H_{16}N_4OS$.

Principal Sources.—Most natural foodstuffs contain a moderate amount of this vitamin, but none has it

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in very high concentrations. Whole-grain foods (*e.g.*, home-pounded rice, atta, etc.), pulses, egg and liver are good sources of this vitamin. The vitamin B_1 content of foodstuffs is expressed, as shown in tables on pages 28-36, in terms of the International Unit; the International Unit for vitamin B_1 is the vitamin B_1 activity of 10 milligrammes of the International standard preparation which is a concentrated preparation of the vitamin (extracted from rice polishings) adsorbed on Fuller's earth.

Properties.—Vitamin B_1 is soluble in water and is much more resistant to heat than vitamin A, and is not oxidised by exposure to air. In an acid or slightly acid medium, it is not appreciably affected by exposure to a temperature of 100°C, but is destroyed by a temperature above 100°C, and the rate of destruction increases gradually with increasing temperature. In the baking of bread and in the ordinary process of cooking, no serious diminution in vitamin B_1 content may be expected. In an alkaline medium (for instance, when sodium bicarbonate is added to facilitate cooking or to preserve the colour of vegetables when they are cooked), it is readily destroyed even at low temperatures.

Effect of Absence from Diet.—Deficiency of vitamin B_1 prevents carbohydrate metabolism from proceeding normally and causes loss of appetite and constipation. Its absence is responsible for the disease known as beriberi which is distinguished by the occurrence of pain and weakness in the limbs, loss of sensation in the skin, oedema and weakness of the heart.

Vitamin B_2.—This vitamin is now known to be multiple in nature and to include lacto-flavin (which has the formula $C_{17}H_{20}O_6N_4$), ribo-flavine, the pellagra-preventive substance and other constituents, the physiological and nutritional significance of which is at present obscure.

Principal Sources.—Vitamin B_2 has practically always been found mixed with vitamin B_1 in natural foodstuffs ; different food-materials, however, contain them in different proportions. Milk, skimmed milk powder, egg, muscle meat, pulses, and green leafy vegetables are fairly rich in this vitamin.

Properties.—Vitamin B_2 is soluble in water and much more thermostable than vitamin B_1, withstanding the action of high temperature in the steam oven for 2½ hours.

Effect of Absence from Diet.—Lack of this vitamin checks the growth of the young, gradually injures the health at any age, and is regarded as the cause of the disease pellagra which is characterised by distinctive skin eruptions (redness and swelling of the skin, development of blisters, etc., being the chief signs of pellagrous eruption) accompanied by disturbances of the alimentary tract (consisting of stomatitis, gastric eructations and diarrhoea) and nervous troubles (mental deterioration, atrophic paralysis and sensory disturbances).

Vitamin C.—This vitamin has been named ascorbic acid and is a hexuronic acid, with the formula $C_6H_8O_6$. It plays an extremely important part in normal nutrition.

Principal Sources.—The most important sources of vitamin C are some varieties of fresh fruits (*e.g.*, guava, lemon, lime, lichi, orange, papaya, pine-apple, plum, shaddock, etc.) and fresh and green leafy vegetables. It is absent from dried seeds (*e.g.*, pulses) but is formed during the process of germination. When fresh fruits and fresh and green leafy vegetables are not easily obtained, sprouted pulses (which contain 10 to 15 milligrammes of vitamin C per 100 grammes) may be used as a cheap and easily available source of this vitamin. In the tables on pages 28-36 the vitamin C content of foodstuffs has been expressed in terms of milligrammes of ascorbic acid per 100 grammes. The International Unit of vitamin C corresponds to the vitamin C activity of 0·05 milligrammes of l-ascorbic acid. One milligramme of ascorbic acid is, therefore, equivalent to 20 Units of vitamin C.

Properties.—Vitamin C is soluble in water and is characteristically less stable than the other known vitamins, being extremely sensitive to heat and oxidising agents (*e.g.*, oxygen of the air), particularly in an alkaline medium. The vitamin C content of foods is therefore markedly diminished when they are cooked.

Effect of Absence from Diet.—The absence of vitamin C from the diet produces a condition called scurvy, its main symptoms being weakness, skin eruptions, small haemorrhages under the skin, and haemorrhage from the gums and other mucous membranes. Shortage of vitamin C also gives rise to serious faults in tooth structure and dental health.

Vitamin D.—This vitamin also produces growth effect to a minor extent, but it is chiefly required for the correct utilisation of calcium salts and phosphates in the nutrition of the growing and adult skeleton. It has been artificially prepared by irradiating ergosterol (which occurs plentifully in ergot which is a fungus growth on rye and in yeast, and a practically unlimited supply of it may be available by growing yeast under suitable conditions) with ultra-violet rays and named calciferol which is an isomer of ergosterol ($C_{28}H_{44}C$, H_2O).

Principal Sources.—Vitamin D is sparsely distributed in ordinary foodstuffs. It is found mainly in fish livers (cod liver oil and halibut liver oil being extremely rich in it), in the flesh of fat fish and in the yolk of egg, and is present to a lesser degree in milk and milk-fat. The vitamin D content of foods can be increased by irradiating them, when any ergosterol which they may contain will be converted into vitamin D. Exposure of animals to ultra-violet light or to ultra-violet rays in sunshine can replace to a certain extent the necessity for the presence of vitamin D in the diet, as the ergosterol contained in the skin is converted into vitamin D by the action of ultra-violet rays. The vitamin D content of certain foodstuffs is given below in terms of International Units, the International Unit of vitamin D corresponding to the vitamin D activity of 1 milligramme of the International standard solution of irradiated ergosterol.[1]

Substances	International Units per gramme
Calciferol	40,000,000
Halibut liver oil	2,000 to 4,000
Cod liver oil	mostly 100 to 200
Egg [2]	0·8
Egg-yolk	1·5 to 5·0
Butter	about 1
Milk	0·05

Properties.—Vitamin D is soluble in fat and is fairly stable to heat.

Effect of Absence from Diet.—(1) Absence of vitamin D is an important factor in the causation of rickets which is characterised by bones which are soft from deficient deposition of calcium phosphate and are, therefore, easily bent under the weight of the body, so that serious deformities may develop. It must be noticed that rickets may arise when the diet does not contain an adequate amount of calcium and phosphorus in the right proportion and when enough of vitamin D is not supplied through the intake or is not produced in the body by the action of ultra-violet rays. Rickets rarely occurs in countries (*e.g.*, India) which enjoy abundant sunshine throughout the year, but in countries (*e.g.*, in the temperate regions of Europe and America) where bright sunlight is scanty, especially in winter, it is difficult for the children to obtain enough of this vitamin unless the diet is fortified by the addition to it of cod liver oil or other fish liver oil.

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[1] "The Extra Pharmacopoeia"—Martindale and Westcott, 20th edition.

[2] "Physiological Bases of Nutrition"—Report of the Technical Commission appointed by the Health Committee of the League of Nations, Nov., 1935.

(2) Osteomalacia (in which the bones—especially the pelvic girdle, ribs and femora—become soft and deformed, and deformation of the pelvis may be so severe as to necessitate Caesarean section to procure delivery of the child) is a form of adult rickets limited to child-bearing women, and the symptoms usually appear during pregnancy and lactation, and their onset is due to the demands made by the foetus and by the mammary glands on the calcium reserves in the bones the of mother.

(3) Want of sufficient vitamin D in the diet is also one of the causes of dental caries.

Vitamin E.—This vitamin is necessary for successful reproduction in rats, but its nature is not definitely known.

Principal Sources.—Vitamin E is extremely widely distributed in foodstuffs, green leaves and the embryo of seeds (*e.g.*, wheat germ) being the richest sources.

Properties.—Vitamin E is soluble in fat and is remarkably resistant to heat.

Effect of Absence from Diet.—In the absence of vitamin E, there is a gradual loss of the reproductive power in the male rat ; in the female "conception takes place, but the embryo fails to attain full development, dies in the uterus and becomes absorbed." So far no conclusive clinical observations have been published regarding its importance to human beings. As the vitamin is active in very small amounts and as it is widely distributed among foods, the possibility of any lack of it can seldom arise.

The following tables give a list of some of the common food articles with their average contents of the principal nutrients :—

Composition and Caloric Value of Food-stuffs [1]

Name of foodstuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					Calories per 100 grammes (approximately)
	Water	Proteins	Fats	Carbo-hydrates	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B_1 (International Units per 100 grammes)	Vitamin B_2 ‡	Vitamin C (Milligrammes per 100 grammes)	
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Cereals—															
Rice, raw, home-pounded ...	12·2	8.5	0·35	78·25	...	0·70	0·007	0·165	0·002	...	...	100	Poor	...	355
Rice, raw, milled...	13·0	6.8	0·60	79·10	...	0·50	0·007	0·108	0·001	0	...	26	Poor	...	355
Rice, parboiled, home-pounded	12·6	8.5	0·40	77·60	...	0·90	0·01	0·277	0·002	...	...	100	Poor	...	355
Rice, parboiled, milled ...	13·5	6.40	0·60	78·90	...	0·80	0·007	0·149	0·002	0	...	100	Poor	...	255
Wheat flour (Maida) ...	13·3	11.0	0·90	74·1	0.3	0·40	0·02	0·092	0·001	...	...	...	...	0	355
Whole wheat flour (Atta) ...	12·8	11.8	1·4	71·3	1.2	1·5	0·054	0·315	0·005	...	108	230	+	...	355

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[1] References—(1) Aykroyd, W. R.—"The nutritive value of Indian foods," Health Bulletin No. 23. (2) Sherman, H. C.—"Food and Health." (3) McCarrison, R.—"Food." (4) Basu, C. L—'Khadya (A Treatise on Food)" (5) Wilson, H. E. C., Ahmed, B., and Mallick, D. N.—"The ash, calcium and phosphorus content

of some common Bengali food-stuffs," Indian Journal of Medical Research, January, 1937. (6) Ahmed, B., Mallick, D. N., and Mazumdar, B. N.—"The carotene content of some common Bengali food-stuffs," Indian Journal of Medical Research, January, 1937. (7) De, N. K.—"The spectrometric method of assaying vitamin A and carotene with further data on the vitamin A activity of Indian foodstuffs," Indian Journal of Medical Research, January, 1937. (8) Chakrabarty, R. K.—"The vitamin C content of some Indian food materials," Indian Journal of Medical Research, October, 1935. (9) Ahmed, B.—"The vitamin C value of some common Indian fruits, vegetables and pulses by the chemical method," Indian Journal of Medical Research, April, 1935. (10) "Vitaminology" (Bengal Chemical and Pharmaceutical Works, Ltd). (11) De, N. K.—"The carotene content of some Indian vegetable food-stuffs, with a preliminary note on its variation due to storage," Indian Journal of Medical Research, April, 1936. (12) McCay, D.—"Investigations on Bengal Jail Dietaries."

† The figures given represent percentages, *i.e.*, grammes per 100 grammes, tolas per 100 tolas, and so forth. The following table may be useful for conversion of the metric and avoirdupois weights into Indian measures :—

1 tola = 11·4 grammes.
1 ounce (avoirdupois) = 2½ tolas = 28·4 grammes.
1 pound (avoirdupois) = 16 ounces = 40 tolas (½ seer) = 453·6 grammes.
100 grammes = 3·5 ounces (avoir) = 8.75 tolas.

‡ No International Unit has yet been established for vitamin B_2. The relative merits of different food-stuffs as sources of the vitamin are indicated by means of signs, the significance of which is as follows :—

+ signifies that the vitamin is present in the food but not in large amounts.
++ signifies that the food is a good source of the vitamin.
+++ signifies that the food is a very rich source of the vitamin.

"Poor" means that the food contains the vitamin but is an almost negligible source of it.

The absence of any symbol indicates that no information is available.

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	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					
						Mineral constituents				Vitamin A	Carotene				
Name of food-stuff	Water	Proteins	Fats	Carbo-hydrates	Fibre	Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes		Vitamin B₁ (International Units per 100 grammes)	Vitamin B₂ ‡	Vitamin C (milligrammes per 100 grammes)	Calories per 100 grammes (approximately)
Sugar and Jaggery—															
Jaggery (gur) ...	3·9	0·4	0·1	95	...	0·6	0·075	0·038	0·011	...	280	...	...	...	390
White sugar ...	Trace	...	...	99	...	...	...	...	...	0	...	0	0	0	405
Milk—															
Human ...	87·6	1·2	3·7	7·2	...	0·3	0·034	0·015	...	208	0	...	...	3.5	70
Ass's ...	89·6	2·3	1·6	6·0	...	0·5	...	...	...	...	...	...	...	...	50
Goat's ...	86.3	3·6	4·0	5·3	...	0·8	0·128	0·103		182	0	...	...	0.9	70
Cow's ...	87·6	3·3	3·6	4·8		0·7	0·120	0·093	0·0002	180	0	...	++	0.7	65
Buffalo's ...	82.3	4·8	7·7	4·4	...	0·8	0·203	0·125	...	162	0	...	...	1.0	110
Skim milk powder.	4·1	38.0	0·1	51·0	...	6·8	1·37	0·095	0·001	0	0	165	+++	...	365
Egg—															
Duck's ...	71·0	13·6	13·7	0·7	...	1·0	0·07	0·261	0·002	1,200	...	...	+++	...	185
Hen's ...	73·4	13·3	13·3	...	...	1·0	0.05	0·271	0·002	1,200	1,000	...	+++	...	175
Meat—															
Beef, muscle ...	73·8	22·6	2·6	...	...	1·0	0.004	0·190	0·0007	59	0	50	++	...	115
Duck, muscle	...	20·3	10·3	...	...	...	...	...	...	...	...	...	...	...	180
Fowl, muscle ...	72·6	23·3	3·1	...	...	1·0	...	...	...	...	...	...	...	...	125

Name of food-stuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					Calories per 100 grammes (approximately)
	Water	Proteins	Fats	Carbo-hydrates	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B₁ (International Units per 100 grammes)	Vitamin B₂ ‡	Vitamin C (milligrammes per 100 grammes)	
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Meat (*Continued*)—															
Goat, muscle ...	72·2	24·1	2·5	...	...	1·2	...	...	...	...	...	...	...	...	120
Mutton, muscle ...	66·9	18·5	13·8	...	...	1·3	0·147	0·151	0·002	30	0	60	+	...	200
Liver, sheep ...	70·4	19·3	7·5	1·4	...	1·4	0·006	0·378	0·006	22,000	0	120	+ + +	...	150
Fish—															
Bhetki, muscle ...	78·9	16·2	4·1	...	...	0·8	...	...	...	...	...	16	...	...	105
Hilsa, muscle ...	75·1	14·8	9·2	...	...	0·9	0·102	0·352	...	Trace	Trace	10	...	...	145
Koi, muscle ...	80·9	17·7	0·4	...	...	1·0	0·131	0·252	...	Trace	Trace	...	...	...	75
Lobster, muscle ...	83·1	15·5	0·5	...	...	0·9	...	...	...	...	...	...	...	...	65
Magur, muscle ...	78·8	19·5	0·5	...	...	1·2	...	...	...	...	...	...	...	...	85
Mrigal, muscle ...	80·6	18·1	0·3	...	...	1·0	...	...	...	...	...	10	...	...	75
Rohit, muscle ...	78·7	17·5	7·4	...	...	1·4	0·073	0·314	...	...	100	18	...	...	140
Tengra, Muscle ...	81·3	17·3	0·8	...	...	1·1	0·065	0·302	...	...	...	...	...	...	75

Name of food-stuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					Calories per 100 grammes (approximately)
						Mineral constituents				Vitamin A	Carotene	Vitamin B_1 (International Units per 100 grammes)	Vitamin B_2 ‡	Vitamin C (milligrammes per 100 grammes)	
	Water	Proteins	Fats	Carbo-hydrates	Fibre	Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Pulses (dals)—															
Bengal gram (Chola dal) ...	11·2	19·9	4·3	51·1	10·8	2·7	0·185	0·236	0·009	...	316	93	+ +	...	350
Black gram (Mashkalai dal)	11·2	22·5	1·1	58·0	3·8	3·4	0·200	0·367	0·009	...	64	140	+ +	...	340
Green gram (Mug dal) ...	10·4	24·0	1·2	56·7	4·1	3·6	0·143	0·281	0·008	...	158	155	+ +	...	340
Khensari dal ...	...	28·2	0·6	58·2	...	3·0	0·107	0·496	0·005	...	300	...	...	...	360
Lentil (Masur dal) ...	11·5	25·5	3·0	55·0	2·9	2·1	0·130	0·250	0·002	...	450	150	+	...	355
Peas (Matar dal)...	16·1	19·7	1·1	56·5	4·5	2·1	0·068	0·298	0·004	...		150			330
Red gram (Arhar dal) ...	12·0	21·7	3·3	54·3	5·1	3·6	0·136	0·264	0·008	...	220	190	+ +	...	340
Soya bean ...	8·1	43·2	19·5	20·9	3·7	4·6	0·237	0·680	0·011	...	710	300	+ +	...	445
Fats and oils—															
Butter ...	14·0	1·0	85	...	...	...	...	...	...	2,400	130	...	...	...	795
Ghee	...	...	100	...	...	...	...	...	...	1,700	...	...	...	...	950
Mustard oil ...	...	...	100	...	...	...	...	...	...	...		...	...	...	930
Red palm oil ...	...	...	100	...	...	...	...	...	...	...	14,000	..	...	...	930
Cod liver oil ...	...	...	100	...	...	...	...	...	...	45,000-168,00	...	...	...	...	930
Halibut liver oil...	...	...	100	...	...	...	...	...	...	3.9000000	...	...	...	...	930

Name of food-stuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					Calories per 100 grammes (approximately)
	Water	Proteins	Fats	Carbo-hydrates	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B_1 (International Units per 100 grammes)	Vitamin B_2	Vitamin C (milligrammes per 100 grammes)	
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Leafy vegetables—															
Cabbage (Bandha kapi) ...	90·2	1·7	0·1	6·4	1·0	0·6	0·034	0·046	0·0007	...	2000	50	...	124	25
Colocasia stems ...	93·5	0·8	0·3	4·1	0·6	1·2	0·062	0·024	0·0005	...	...	...	...	...	20
Gima sak ...	...	2·1	...	...	...	...	0·16	0·03	0·02	...	...	25	...	...	...
Hincha sak ...	...	3·97	...	...	...	...	0·182	0·1	0·009	...	...	28	...	...	...
Ipomoea (Kalmi sak) ...	...	2·9	0·4	4·3	...	2·1	0·115	0·048	0·003	...	3,000- 9,000	29	...	157	30
Pumpkin leaves (Kumra sak)	...	...	...	...	...	...	...	...	...	...	9,600- 12,000	8	...	...	...
Lal sak ...	...	4·9	0·5	5·8	...	3·0	0·5	0·1	·021	...	2,300- 11,000	29	+	173	...
Mint (Podina) ...	83·0	4·8	0·6	8·1	1·9	1·6	0·204	0·07	0·015	...	2,500- 7,000	...	...	...	45 55
Palta (leaves of Patal) ...	...	...	...	...	...	...	0·462	0·01	0·07	...	10,000	12	...	...	...
Puin sak ...	86·1	1·2	Trace	Trace	12·1	0·6	0·154	0·06	0·007	...	5,000- 5,800	40	...	...	5
Raddish leaves ...	...	...	...	...	...	...	...	...	...	...	12,000- 14,000	...	...	114	...
Spinach (Palong sak) ...	91·0	0·6	Nil	0·5	0·4	1·5	0·061	0·01	0·004	...	3,000- 10,800	71	...	48	5

Name of food-stuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					Calories per 100 grammes (approximately)
	Water	Proteins	Fats	Carbohydrates	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B₁ (International Units per 100 grammes)	Vitamin B₂	Vitamin C (milligrammes per 100 grammes)	
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Non-leafy vegetables—															
Ash gourd (Chalkumra) ...	88·7	0·2	0·1	1·2	9·5	0·3	0·025	0·017	0·0004	...	Trace	21	...	0·9	5
Bitter gourd (Karala) ...	92·4	1·6	0·1	4·3	0·8	0·8	0·023	0·065	0·002	...	210	24	...	88·4	25
Bitter gourd, small variety (Uchcha)	83·1	2·9	1·0	9·9	1·7	1·4	0·015	0·144	0·009	...	210	24	...	88·4	60
Bottle gourd (Lau)		0·2	0·1	2·9		0·5	0·015	0·003	0·0007	...	266				15
Brinjal (Begoon)...	91·7	0·6	0·3	1·9	5·0	0·5	0·024	0·064	0·001	...	5	20	+	22·5	10
Cauliflower (Fulkapi) ...	90·3	1·4	0·7	2·9	3·3	1·4	0·074	0·061	0·001	...	38	110	...	66	25
Carrot (Gajar) ...	86·0	0·9	0·1	10·7	1·2	1·1	0·082	0.03	0·001	...	2,020	60	...	2·5	45
Colocasia (Kachu)	83·8	0·3	0·1	11·2	2·0	1·7	0·018	0·143	0·002	...	40	20	+	Trace	45
Cucumber (Sasha)		0·4	0·1	2·8		0·3	0·012	0·025	0·001	...	290	30	...	7	15
Ladies fingers (Dheros) ...	87·9	2·2	0·2	7·8	1·2	0·7	0·094	0·078	0·001	...	58	21	+	15·6	40
Onion (Peanj) ...		1·8	0·1	13·2		0·6	0·04	0·058	0·001	...	25	40	...	10·5	60
Patal	93	0·7	0·4	1·2	4·0	0·7	0·05	0·12	0·0007	...	1,550	10	...	13	10
Peas, green (Matarsuti) ...	62·3	8·4	0·9	22·4	5·5	0·7	0·019	0·078	0·001	...	3,200	120	...	9·2	135
Plantain, green (Kanchakala) ...	67·9	0·5	0·2	14·6	6·3	0·5	0·005	0·027	0·0006	...	50	15	+ +	24	65
Potato ...	66·7	1·8	0·6	19·9	9·4	0·6	0·004	0·034	0·0006	...	40	40	+ +	17·3	95

Name of food-stuff	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					
	Water	Protein	Fat	Carbo-hydrate	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B₁ (International Units per 100 grammes)	Vitamin B₂	Vitamin C (milligrammes per 100 grammes)	Calories per 100 grammes (approx.)
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	International vitamin A Units per 100 grammes					
Non-leafy vegetables (*Continued*)—															
Pumpkin (Mitha kumra) ...	90·0	0·2	0·1	3·9	5·2	0·6	0·009	0·03	0·0006	...	84	20	...	2·0	15
Radish (Mula) ...	93·2	0·6	0·1	1·8	3·5	0·8	0·046	0·017	0·0004	...	3	60	...	17	10
Ridge gourd (Jhinga) ...	92·8	0·3	0·1	Trace	6·5	0·3	0·055	0·04	0·001	...	600	22	...	...	2
Sheem ...	82·5	1·2	0·6	7·3	7·0	1·4	...	...	...	...	...	...	...	...	40
Snake gourd (Chichinga) ...	...	0·4	0·3	4·5	...	0·7	0·045	0·024	0·001	...	160	...	...	...	20
Sweet potato ...	...	1·2	0·3	30·9	...	1·0	0·017	0·05	0·0007	...	10	...	...	24	135
Tomato, green ...	...	1·9	0·1	4·5	...	0·7	0·016	0·039	0·002	...	320	23	...	31·3	25
Tomato, ripe ...	...	1·0	0·1	3·9	...	0·5	0·008	0·018	0·00008	...	320	40	...	32·2	20
Turnip (Shalgam) ...	...	0·5	0·2	7·5	...	0·6	0·028	0·035	0·0004	...	Trace	40	...	43·4	35
Fruits—															
Almond ...	5·2	20·8	58·9	10·5	1·7	2·9	0·225	0·492	0·003	...	...	80	...	...	675
Apple ...	...	0·3	0·1	13·4	...	0·3	0·013	0·021	0·001	...	Trace	40	...	2·1	55
Banana (Kala) ...	...	1·3	0·2	36·4	...	0·7	0·002	0·045	0·0004	...	Trace	50	...	1·0	155
Bel ...	78·8	0·7	0·7	16·2	2·4	1·2	...	...	...	...	250	...	...	7·6	75
Coconut, ripe ...	36·3	4·4	41·6	13·2	3·6	0·9	0·013	0·243	0·001	...	Trace	Trace	Poor	0·8	460
Water from green coconut ...	95·2	1·4	0·4	2·4	...	0·6	...	...	...	...	...	...	...	1·6	40

	PARTS PER 100 PARTS OF EDIBLE PORTION †									VITAMINS					
Name of food-stuff	Water	Proteins	Fats	Carbo-hydrates	Fibre	Mineral constituents				Vitamin A	Carotene	Vitamin B_1 (International Units per 100 grammes)	Vitamine B_2	Vitamin C (milli-grammes per 100 grammes)	Calories per 100 grammes (approx.)
						Total Mineral matter	Calcium (Ca)	Phosphorus (P)	Iron (Fe)	(International vitamin A units per 100 grammes)					
Fruits (*Continued*)—															
Date, preserved ...	26·1	3·0	0·2	67·3	2·1	1·3	0·067	0·076	0·01	...	600	50	+	Trace	290
Grapes (Angur) ...	85·6	0·8	0·1	10·1	3·0	0·4	0·025	0·019	0·0004	...	15	Trace	...	2·5	45
Groundnut, roasted (Chinabadam) ...	1·0	31·5	39.8	19·3	3·1	2·3	0·045	0·435	0·0002	...	...	... ...	...	...	575
Guava (Peara) ...	76·1	1·4	0·2	14·6	6·9	0·8	0·013	0·04	0·001	...	100	...	...	299	65
Jack fruit ...	78·2	1·9	0·1	17·9	1·1	0·8	0·022	0·028	0·0004	...	540	...	...	10	80
Lemon juice ...	...	0·6	...	...	...	...	0·023	0·01	...	...	...	...	...	38·5	...
Lime juice ...	...	...	...	...	...	...	...	...	...	...	...	...	...	62·5	...
Lichi (Lichoo) ...	...	2.9	0·2	6·6	...	...	...	...	...	...	...	...	...	48	40
Mango, green ...		0.6	0·1	8·8	...	0·4	0·012	0·017	0·004	...	150	...	...	3·2	40
Mango, ripe ...	86·2	0·6	0·1	11·7	1·1	0·3	0·007	0·02	0·0002	...	4800	...	Poor	13	50
Orange juice ...	87·8	0·9	0·3	10·6	...	0·4	0·016	0·022	0·0800	...	350	40	...	67·7	50
Papaya, ripe ...	...	0·5	...	9·5	...	0·4	0·013	0·009	0·0004	...	2020	...	...	45·5	40
Pears (Nashpati) ...	86·0	0·2	...	11·6	1·0	0·3	0·006	0·011	0·0006	...	14	...	...	Trace	45
Pineapple (Anaras) ...	86·5	0·6	...	12·0	0·4	0·5	0·021	0·007	0·0009	...	180—260	...	...	62·9	50
Plums (Kul) ...	...	0·7	0·2	8.9	...	0·4	0·017	0·018	0·0005	...	250	40	...	54	40
Pomegranate (Dalim) ...	78·0	1·6	...	14·6	5·1	0·7	0·009	0·066	0·0002	...	0	...	...	13·6	65
Raisins, preserved	...	1·9	0·2	77·4	...	2·0	0·101	0·075	0·003	...	...	75	...	Trace	325
Shaddock (Batabi lebu) ...	88·2	0·6	...	10·1	0·6	0·5	0·028	0·027	0·00004	...	200	...	...	27	45

CHAPTER II

QUANTITATIVE FOOD REQUIREMENTS

In the previous chapter we have dealt with the dietary constituents and their contribution to nutrition. The actual requirements of the normal human individual may now be examined.

Energy Requirements.—We incessantly spend energy in maintaining the normal temperature of the body and the activities of the lungs, heart and other vital organs and in performing external muscular work. The energy expended by the human individual is usually expressed in terms of Calories, a Calorie representing the amount of heat required to raise the temperature of 1 kilogramme (2·2 lbs.) of water from 15° C to 16° C. It is from the determination of the number of Calories which we spend per day that we are able, in turn, to determine the number of Calories that we need daily from foods to make good the loss. A diet is, therefore, sufficient in quantity when it provides sufficient energy to meet the needs of the individual ; the foods selected must also bring us other nutrients at the same time. It will be noted that of the six dietary constituents, three only (namely, proteins, carbohydrates and fats) evolve energy either as heat or work on complete oxidation in the body. 1 gramme of protein or 1 gramme of carbohydrate, as ingested in the diet, will yield 4·1 Calories in the body, whereas 1 gramme of fat will produce 9·3 Calories. In calculating the potential energy contained in 100 grammes of a food article, it is, therefore, necessary to multiply the percentage of proteins and carbohydrates by 4·1 and the percentage of fat by 9·3.

The total energy liberated per hour per day by a man or woman of a given age and height and weight is usually computed from (*a*) the basal metabolism (that is to say, the energy output of an individual at complete bodily and psychical rest after the digestion and absorption of the last meal has been completed), and (*b*) the additional expenditure of energy involved in external muscular work and in minor activities of daily life. The eating of proteins, carbohydrates or fats—but particularly proteins—is followed by an increase of heat production, and the extra heat thus set free must also be added to the basal metabolism.

It has been found that the basal metabolism is most closely related to the surface area of the body. The basal metabolism, according to Du Bois, is about 40 Calories in the adult man and about 37 Calories in the adult woman per square metre of body surface per hour.[1] "It is about 1 Calorie less for each additional ten years of age from 30 to 70 years in both sexes. Thus for a man of 40 we can take 39 Calories."[2] The normal basal metabolism of any given individual can, therefore, be predicted by finding out his surface area from the following formula[3] :—

$$S = W^{0{\cdot}425} \times H^{0{\cdot}725} \times {\cdot}007184$$

where S = surface area in square metres.
W = weight in kilogrammes,
and H = height in centimetres.

The day—for purposes of assessment may be divided into three periods of 8 hours each—sleep, free time and work.

(*a*) In 8 hours' sleep, we allow basal metabolism.

(*b*) In the assessment of energy expenditure during free time (that is to say, during the time at the man's

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[1] It is a question for the medical authorities to decide whether the basal metabolism is lower in a warm country like India, but till they rule otherwise, we have no other alternative than to accept Du Bois' figures.

[2] Starling's "Principles of Human Physiology," 1933, p 519.

[3] By substituting the value of W and H in the above formula, we can find out S in the following manner :—

Suppose W = 70 kilogrammes
H = 160 centimetres

Then,

$$S = 70^{0{\cdot}425} \times 160^{0{\cdot}725} \times {\cdot}007184$$

$$\text{or } \log S = \log 70^{0{\cdot}425} + \log 160^{0{\cdot}725} + \log {\cdot}007184$$

$$= 0{\cdot}425 \times \log 70 + 0{\cdot}725 \times \log 160 + \log {\cdot}007184$$

$$= {\cdot}2384$$

Therefore $S = \text{antilog } {\cdot}2384 = 1{\cdot}732.$

own disposal), it is suggested that the provision for the average man would be adequate if the basal metabolism for 8 hours be increased by 10 per cent. for the action of food and by 20 per cent. for minor activities.

(c) Work is assessable as the basal metabolism *plus* the increment due to muscular work. The amount of external muscular work done is calculated in terms of kilogramme-metres, 1 kilogramme-metre denoting the amount of work done in raising a mass of 1 kilogramme through a vertical distance of 1 metre. A man may perform in 8 hours without fatigue about 100,000 kilogramme-metres of work. Accurate determinations have shown that these work units can be converted into heat units, approximately 426 kilogramme-metres being the equivalent of 1 Calorie. So 100,000 kilogramme-metres are equivalent to about 235 Calories. Repeated experiments on subjects have shown further that the mechanical efficiency with which the work is done is generally about 25 per cent.; by this is meant that only 25 per cent. of the energy liberated from food can be converted into external work, and the remaining 75 per cent. is dissipated as heat. Thus the performance of mechanical work equivalent to 235 Calories entails a total expenditure of 235 × 4 or 940 Calories.

We may now express the total daily energy output in Calories for an adult working man or an adult working woman of a given height and weight, while engaged in known work or activity, in the following manner :—

	Total energy output of a working adult person (in Calories)	
Periods of the day	Man Height—160 cm. Weight—70 kilogram Surface area—1·7 sq. metre	Woman Height—155 cm. Weight—55 kilogram Surface area—1·53 sq. metre
8 hours' sleep (basal metabolism) ...	(1·7 × 40) × 8 or 68 × 8 or 544	(1·53 × 37) × 8 or 56·6 × 8 or 452·8
8 hours' free time (basal metabolism *plus* 10 per cent. for dynamic action of food *plus* 20 per cent. for minor activities) ...	(68+6·8+13·6) × 8 or 88·4 × 8 or 707·2	(56·6 + 5·66 + 11·32) × 8 or 73·58 × 8 or 588·64
8 hours' work[1] (basal metabolism *plus* the energy liberated during muscular work). Suppose the man performs 100,000 kilogramme-metres of work which involves an expenditure of 940 Calories, and the woman performs two-thirds of the work of a man ...	(68 × 8) + 940 or 1484	(56·6 × 8) × 630 or 1082·8
Total...	2735·2	2124·2

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[1] The expenditure of energy in the performance of various external work may be shown as follows :—Light work, up to 75 Calories per hour of work ; moderate work, 75 to 150 Calories per hour of work ; hard work, 150 to 300 Calories per hour of work ; and very hard work, 300 Calories and upwards per hour of work. Men in sedentary employment (includ-

These figures (2735·2 Calories and 2124·2 Calories) represent the actual energy loss of the persons and are, therefore, equivalent to the amount of energy which must be supplied in the form of foods to make good the loss. A small percentage of food escapes digestion and absorption and is eliminated in the faeces. It has been reckoned that to allow for this loss, food as purchased should have a Calorie value 10 per cent. higher than actual requirements. Thus, 2,735 and 2,124 net Calories (*i.e.*, the amount of energy available from the food actually assimilated) require an intake of food with a Calorie value of about 3,000 and 2,400. The energy value of the diet must be greater if more work is done, and *vice versa*.

The energy needs of children are very difficult to compute. The basal metabolism is considerably greater per square metre of surface in children than in adults and is represented by a gradually declining curve, passing from 56 Calories at the age of 3 to 40 at the age of 20.[1] Children also do considerable muscular work.

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ing all classes of brain workers) may not expend more than 200 to 400 Calories in the performance of external work. Women often do housework at home. Household duties are reckoned as equivalent to light work (involving an expenditure of energy up to 75 Calories per hour) for 8 hours daily. [Ref : (1) Starling's "Principles of Human Physiology"; (2) "Report on the Physiological Bases of Nutrition" drawn up by the Technical Commission of the Health Committee of the League of Nations, 1936.]

[1] "Nutrition in Children"—E. Lesne and G. Dreyfurs, Bulletin of the Health Organisation, League of Nations, September, 1936.

Moreover, as growing children are always putting on weight on account of the growth of tissues and organs, an excess of food materials over and above that needed to furnish the energy output of the body must be taken for their conversion into body materials for growth. Many investigators have attempted to lay down standards of Calorie requirements for different ages in terms of the "average man" taken as 1. In 1932 an expert committee, convened by the Health Organisation of the League of Nations, drew up a scale of food requirements for various ages and sexes, which is as follows:—

Class	Coefficient
Adult man ...	... 1·0
Adult woman ...	... 0·8
Boys, 13 upwards ...	... 1·0
Girls, 13 upwards ...	... 0·8
Child, 12 and 13 ...	... 0·8
Do. 10 and 11 ...	... 0·7
Do. 8 and 9 ...	... 0·6
Do. 6 and 7 ...	... 0·5
Do. 4 and 5 ...	... 0·4
Do. 2 and 3 ...	... 0·3
Do. 0 to 2 ...	... 0·2

(1 = 3,000 Calories gross)

These figures have been very widely accepted in calculating the average food requirements of each member of a family. It must, however, be borne in mind that the variation of such factors as height, weight, age of maturity, amount of work performed, etc.—factors which influence the relative food intake of different family members—makes it impossible that one particular scale should everywhere correspond with real values.

DISTRIBUTION OF THE ENERGY-YIELDING CONSTITUENTS IN A NORMAL DIET

The number of Calories required should be contributed by proteins, carbohydrates and fats in certain proportions.

Proteins.—What constitutes an adequate amount of proteins varies rather widely according to the circumstances of life. Prof. Sherman of Columbia University recommends 1 gramme of protein daily per kilogramme of normal body weight (or 70 grammes of proteins for a normal adult person weighing 70 kilogrammes) for the normal upkeep of the healthy full-grown body. The Technical Commission of the Health Committee of the League of Nations[1] have also accepted a daily intake of 1 gramme of protein per kilogramme of body weight as a minimum standard of protein requirements for all adults. It is undesirable from physiological or pecuniary standpoints to eat proteins in large excess of our requirements. A part of the total proteins should, however, be of animal origin to ensure that all the essential amino acids are supplied in the diet in adequate amounts. There is not as yet a consensus of opinion as to the most advantageous intake of animal proteins Recently, Prof. E. F. Terroine[1] of Strasburg University has shown that an adult person of 70 kilogrammes body weight loses by the functioning of the body about 3 grammes of nitrogen or about 19 grammes of proteins a day. This loss of the nitrogenous substance of the organism will be made good by an intake of 19 grammes of proteins (provided there are sufficient carbohydrates and fats to meet the energy requirements) with a biological value of 100 per cent. and a digestibility of 100 per cent. The table on page 5 shows that the digestibility of proteins drawn from animal sources is above 90 per cent. and the biological value rarely falls below 90. When, for instance, the biological value is 90 and the digestibility is 100 per cent., $\frac{19 \times 100}{90}$ or 21·1 grammes of the proteins will be required for maintaining the nitrogen equilibrium of a man whose weight is 70 kilogrammes. When the digestibility is 90 per cent., $\frac{21{\cdot}1 \times 100}{90}$ or 23·4 grammes will be needed. The adoption as a standard of the lowest amount of proteins to which the body can adjust itself is not, however, advisable, and it is necessary to allow a fair margin for non-absorption and waste. As stated previously, 70 grammes of proteins per day per adult person weighing 70 kilogrammes have been regarded as a satisfactory minimum ; if 70 grammes of total proteins include 23·4 grammes (or roughly one-third of the total amount) of animal proteins, which are themselves of high biological value and which will also supplement the medium and low quality proteins in the diet and thereby raise their value to a high level, there will be enough of proteins in the diet not only to satisfy the needs of the adult body but also to provide an ample margin of security. The protein needs of women during pregnancy and lactation are greater than at other times, because the food proteins must not only repair the wear and tear of the tissues but also supply the materials for the building up of new proteins to contribute to the formation of the foetus (in the case of pregnant women) and the production of milk proteins (in the case of nursing mothers). Growing children also need more proteins than adults since the proteins supplied by foods must simultaneously replace tissue waste and provide for the requirements of growth. The following allowances of total proteins are recommended [1] :—

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[1] "Report on the Physiological Bases of Nutrition" drawn up by the Technical Commission of the Health Committee of the League of Nations (1936).

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[1] Terroine, E. F.—"The Protein Component in Human Diet," Bulletin of the Health Organisation, League of Nations, September, 1937.

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[1] "Report on the Physiological Bases of Nutrition" drawn up by the Technical Commission of the Health Committee of the League of Nations (1936).

Age (years)	Grammes of proteins per kilogramme of body weight
1—3	3·5
3—5	3·0
5—15	2·5
15—17	2·0
17—21	1·5
21 and upwards	1·0
Nursing women	2·0
Pregnant women—	
0—3 months	1·0
4—9 months	2·0

It must be noted that proteins derived from animal sources (especially, the proteins of milk and egg) should form a large proportion of the total proteins in the diet of growing children, of pregnant women and nursing mothers, and of all people who require "building up" (*e.g.*, convalescents from a wasting disease, chronically under-nourished persons as in tuberculosis, etc).

Carbohydrates.—These are, as a rule, the cheapest and most readily obtainable constituent of any diet. The great bulk of the food consumed by the average man of average income is, in fact, of a carbohydrate nature. Carbohydrates fulfil other functions in the body besides the provision of energy. In the absence of sufficient carbohydrates in the diet, glucose is manufactured in the body out of proteins; carbohydrates, therefore, spare the break-down of proteins in order that they may be used exclusively to replace tissue waste and to build up the proteins in the development of the individual from the earliest infancy up to adult age. A sufficient amount of carbohydrates is also necessary for the proper utilisation of fats by the body. In case the amount of carbohydrates ingested is greatly reduced and the fats supply too high a proportion of the energy value of the diet, β-hydroxy-butyric acid and aceto-acetic acid may be formed (on account of the incomplete oxidation of fats) and may accumulate in the body, giving rise to mild acid intoxication. When there is too much of carbohydrates in the diet, a lot of it is left over in the intestine where it ferments and produces gas and irritating acids. This may result in flatulence, indigestion and diarrhoea. Excessive amounts of carbohydrates also prevent the proper absorption, from the intestines, of the proteins and vitamins contained in the different food materials composing the diet. Generally speaking, a normal diet of 3,000 Calories should contain not more than 500 grammes of carbohydrates, furnishing about 68 per cent. of the total Calories.

Fat.—Fat can be produced in the body from carbohydrates. It would thus seem that, given sufficient carbohydrates in the diet, there should be no absolute need for fats. But fat is an essential constituent of the diet and " it has been shown that foodstuffs completely freed from all fats and other lipoid materials will not serve to maintain life."[1] In estimating the amount of fat which an adequate diet ought to contain, the following facts must also be kept in mind :—

(*a*) Fat stays longer in the stomach than proteins, and proteins longer than carbohydrates. In a mixed diet, then, the greater the proportion of fat, the longer the food stays in the stomach. On this account a meal containing too little fat is deficient in staying power and individuals feel hunger pangs too shortly after the meal is taken. In this way the efficiency of the work is affected as man is unaccustomed to work with the alimentary canal entirely at rest.

(*b*) Weight for weight, fat provides more than twice the amount of energy provided by either protein or carbohydrate. The inclusion of fats in the diet makes it possible to provide sufficient Calories without increasing the bulk of the diet to a degree which taxes the capacity of the digestive tract. If the fat-content is reduced, excessive amounts of carbohydrates have to be taken to make up the energy requirements. The amount of carbohydrates which can be ingested is, however, limited by man's power of digestion and assimilation, and overloading the intestines with carbohydrates leads, in many individuals, to abnormal fermentation, the production of gases and general discomfort. It is usually stated that 70 to 100 grammes of fat should be provided in a normal diet, and it should be taken in as assimilable a form as possible. If the fat is not well digested, the amount may be reduced to 50 grammes, but when there is an unusually large increase in the energy expenditure of the body, either in the form of work or in consequence of exposure to cold, the bulk of food must be of considerable importance, and the fat ration should, therefore, be high. It should be remembered that more fat is needed during infancy and childhood than in later life, infants at the breast receiving about half of their Calories in the shape of fat.

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[1] E. P. Cathcart—" Nutrition and Dietetics."

MINERAL SALTS

As stated on page 12, four of the mineral elements (*e.g.*, calcium, phosphorus, iron and iodine) are of outstanding importance, not only because of their own function but because they are those most likely to be present in insufficient quantities in the average diet. A well-balanced diet should contain the following amounts of calcium, phosphorus and iron [1] :—

	Calcium	Phosphorus	Iron
Adults (other than pregnant women and nursing mothers)	0·75 gramme	1·5 grammes	20 milligrammes
Pregnant women and nursing mothers	1·5 ,,	2·0 ,,	
Growing children	1 ,,	1·5 ,,	

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[1] References—Aykroyd, W. R.—" Health Bulletin No. 23 " ; McCarrison, R.—" Nutrition and National Health " (The Journal of the Royal Society of Arts, 28th August and 4th September, 1936) ; Sherman, H. C.—" Food and Health," Report by the Technical Commission on Nutrition on the work of its third session held in London (1937).

As regards iodine, normally the body gets enough of this element in the form of iodides in the drinking water and table salt, so that the iodine content does not figure as a practical factor in food values. Only in regions, in which there is a special paucity of iodides in drinking water and in which also the commonly used table salt is poor in iodides, or where the soil and hence the vegetable foods grown on it are deficient in iodine, do we find evidence of iodine deficiency in nutrition. Such a situation can be safeguarded by the use of sea-fish or of iodised table salt.

So far as other mineral salts are concerned, it seems safe to assume from a practical standpoint that a diet adequate in all other respects will be adequate as a source of any other essential mineral ingredient without special planning. It should be kept in mind, however, that certain food materials contain a large excess of acid-forming over alkali-forming elements ; the acid-forming tendencies of these substances must, therefore, be balanced by including in the diet plenty of those foodstuffs which are predominantly basic.

WATER

In considering the water balance of metabolism, we have, as sources of supply, (1) the drinking water, (2) the water in our food, and (3) the water resulting from the oxidation of proteins, fats and carbohydrates. In the output, we have (1) the amount excreted in the urine, (2) that lost by perspiration and in the expired air, and (3) that lost in the faeces. A small amount of water is also lost each day through the medium of the nasal secretions, tears, sputum, etc. Apart from the water obtained from our foodstuffs and that derived from the oxidation of proteins, carbohydrates and fats in the diet, an adult person should ordinarily drink every day about 60 ounces of pure water—more, of course, when active exercise is taken, or in hot weather. A cup of tea or a glass of milk can replace an equivalent amount of water. The drinking of a reasonable amount of water with meals will promote the secretion and activity of the digestive juices, and the digestion and absorption of the ingested food. But it should be remembered that usually the food consumed is composed largely of water and it is better not to dilute the gastric juice more than is necessary and prevent it from functioning properly. Water is best taken half an hour before or two hours after the meal. It is also wise to drink a glass of water first thing in the morning and last thing in the night.

VITAMINS

In recent years International Units for vitamins A, B_1, C and D, based on standard substances, have been widely used throughout the world, and attempts have been made to estimate human requirements of certain of the vitamins in terms of various units:—

Vitamin A.—It is probable that 2,000-4,000 International Units daily may be regarded as a safe allowance for an adult. The needs of infants, growing children and pregnant and lactating women exceed those of adults.[1]

Vitamin B_1.—An allowance of 10 International Units per 100 calories of food-intake (or 300 International Units for an adult receiving a diet of 3,000 Calories) seems to be adequate. The diet of pregnant and lactating women should contain 2 to 3 times the minimum allowance for the adult in general.[1]

Vitamin C.—A well-balanced diet for school children and adults should contain some 30-50 milligrammes of ascorbic acid corresponding to 600-1,000 International Units.[2]

Vitamin D.—The dietary requirement of vitamin D depends on the amount of sunshine enjoyed, as well as on the quantities of calcium and phosphorus in the diet. In England the amount of " extra " vitamin D in some form (*e.g.*, cod liver oil or other fish liver oil) needed by infants to prevent rickets and to promote full growth and vigour has been reckoned at from 1,000 to 2,000 International Units.[3]

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[1] Report by the Technical Commission on Nutrition on the work of its third session held in London (1937) ; Bulletin of the Health Organisation, League of Nations, June, 1938.

[2] Health Bulletin No. 23—W. R. Aykroyd.

[3] " Nutrition and Public Health "—Et. Burnet and W. R. Aykroyd; Bulletin of the Health Organisation, League of Nations, June, 1935.

We must, however, emphasise the necessity of an intake of vitamins well above what is needed to support normal growth and prevent the appearance of any specific sign of deficiency so as to secure optimum nutritional well-being. The detailed distribution of the vitamins in the foods is shown in the tables on pages 28-36. For practical purposes, the following generalisation serves as an adequate guide:—

(*a*) Green leafy vegetables are an effective source of vitamin A.

(*b*) Milk fat and eggs give vitamins A and D.

(*c*) All whole cereal grains (*e.g.*, whole wheat flour or atta, unmilled rice, etc.) are rich in vitamin B_1, whereas milled grains are largely deprived of this vitamin. Parboiled milled rice, however, retains this vitamin even after milling.

(*d*) Milk, skimmed milk powder, muscle meat, egg, green leafy vegetables and certain of the pulses are fairly rich in vitamin B_2. From a practical standpoint it may be assumed that a diet adequate in all other respects will be adequate also in this vitamin.

(*e*) Fresh fruits and green leafy vegetables are the practically important sources of vitamin C.

(*f*) Vitamin D is found mainly in fish livers, in the flesh of fatty fishes and in the yolk of eggs and is present, to a lesser degree, in butter and milk.

Exposure of the body to ultra-violet light or to ultra-violet rays in sunshine can replace, to a certain extent, the necessity for the presence of vitamin D in the diet, as the ergosterol in the skin is converted into vitamin D by the action of ultra-violet rays.

(*g*) Vitamin E is widely distributed among foodstuffs, and the possibility of any lack of it can seldom arise when the diet is good in other respects.

CHAPTER III

DIETARY VALUE OF THE PRINCIPAL FOOD-STUFFS

The tables on pages 28-36 show that different foodstuffs vary very much in respect of their contents of the nutrients. Mother's milk supplies all the nutritive constituents in proper proportions to the newly born infant for its normal nourishment and growth, but no single foodstuff will meet satisfactorily all the physiological needs of the individuals from infancy upwards. A number of foodstuffs will, therefore, have to be mixed in such a way that our daily diet contains all the necessary ingredients in the right proportion. Many people must buy nearly all of their foods, and these are derived from a very wide and varied range of supply, and are subject to many stages and methods of handling, transport, storage and preparation. It must be realised that the human body benefits to the full when the food consumed is clean. fresh, unadulterated, un-infected with bacteria and their toxins and free from contamination with poisonous metallic salts ; every departure from these conditions means some deprivation to the consumers, difficulty with digestion and perhaps some injury to health. In this chapter we will deal with the nutritional characteristics of the chief food materials, adulteration of foods, food-borne diseases, and metallic contamination.

NUTRITIONAL CHARACTERISTICS OF THE CHIEF FOOD MATERIALS

Rice.—Rice is sometimes called the greatest of all cereals and is *par excellence* the staple farm product of Bengal. It is the cheapest source of the carbohydrates and proteins. Practically the whole of the carbohydrates in rice is starch which is easily digested, and the proteins of rice are of good quality. Rice is, however, poor in fats, does not contain enough of calcium, phosphorus and iron and is deficient in vitamins A, C and D, but it contains plenty of vitamin E. Although unmilled rice is not a concentrated source of vitamin B_1, it is an important source of this vitamin considering the amount which is consumed daily.

The rice grain (obtained after the removal of husk which surrounds it) is composed of three parts: (*a*) the embryo, or germ, which makes up a very small part by weight of the kernel but which contains a good deal of fat and far more than its *pro rata* share of proteins, mineral salts and vitamins; (*b*) the endosperm, which comprises the bulk of the grain and contains most of the carbohydrates and a fair share of the proteins of the kernel but is relatively poor in mineral salts and vitamins; (*c*) the outer coating or bran, which surrounds the endosperm and the germ and contains most of the fibre and the greater part of the proteins, mineral salts and vitamins of the grain. When rice is prepared from the paddy by a simple process entailing the use of a husking pedal ("dhenki"), it retains most of the nutritive constituents of the grain; with each hulling more and more of the bran coat is lost and consequently the rice becomes poorer in nutritive contents, particularly in vitamin B_1. If the paddy is sent to rice mill, it is turned into white and polished rice on account of the complete removal of the bran layer of the grain; as a result, the proteins, mineral salts and vitamins—which are located in the outer coating of the grain—are lost in the polishings. This does not necessarily mean that we should eliminate milled rice from our diet. Provided other food materials supplement the deficiencies of milled rice, there is no reason why we should not enjoy this food. But when the people are so poor that they cannot afford to buy supplementary foods except in small quantities, it becomes important to see that only home-pounded or lightly-milled rice is supplied. It is interesting to note that parboiled (*i.e.*, "siddha") rice contains more vitamin B_1 than the raw variety (*i.e.*, "atap" rice) milled to the same extent; this is due to the fact that during the parboiling process, the vitamin B_1 is diffused from the outer layer into the inner endosperm.[1] Parboiling also increases the digestibility of rice starch and rice proteins.[1]

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[1] Aykroyd, W. R.—Journal of Hygiene, 1932, 32, 184.

Rice becomes ready for consumption after it is boiled with water, but a considerable proportion of the phosphorus-content and a good deal of vitamin B_1 (which is soluble in water) are lost if the gruel (rice water) is thrown away.

Wheat.—Like rice, wheat is a very cheap source of starch and proteins of the diet. It is richer than rice in proteins (which are, however, of lower biological value than those of whole rice), mineral salts and vitamins. When the entire wheat grain *minus* the husk is ground to powder and the coarser particles of bran are sifted off, it is known as whole wheat flour or atta and contains all the nutrients with which Nature has endowed wheat. White flour (or maida) is obtained by milling wheat and bolting or dressing the resulting wheat meal and is usually the ground endosperm of the grain ; in its preparation, the bran coat and the germ are removed and thrown away, and as a result most of the vitamins and a good deal of the mineral salts and proteins are lost. Wheat flour or atta is made into bread, chapatties (*i.e.*, flat, unleavened bread), etc., the peculiar adhesiveness being due to gluten.

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[1] Basu, K. P and Mukherjee, S.—" Biochemical Investigation on different varieties of Bengal Rice," Indian Journal of Medical Research, January, 1936.

Sugar and Gur.—Refined sugar makes its sole contribution to the diet through its carbohydrate-content. It is a supplementary source of energy and its special dietetic value consists in the fact that in moderate quantities it is readily digestible. Something sweet at the end of the meal enhances its satiety value and does no harm ; but the frequent eating of large quantities of cane sugar is prone to fermentation, with the production and absorption of irritating organic acids and toxic products.

Gur (as obtained from the juice of sugar cane, date palm or palmyra palm) is practically as good as refined sugar as a source of carbohydrate. It is cheaper than sugar and retains a significant proportion of the mineral salts and carotene or vitamin A of the plant juices.

Milk.—Its sole function in nature is to nourish the mammalian young. There are as many kinds of milk as there are kinds of mammals. In each case the young creature has different needs ; consequently, the milk provided for these creatures differs suitably in each case. The natural milk of an animal is designed to afford complete nutrition to the young creature of the same species. Mother's milk is an optimum diet (that is to say, a diet which is capable of maintaining a standard of perfect nutrition which is a state of well-being so that no improvement can be effected by a change in the diet) for the newly-born infant. Cow's milk is a perfect and complete food for the calf. It is an excellent food material for human beings also; for, (*a*) it furnishes proteins of exceptionally good quality ; (*b*) the fats of milk are of low melting point and exist in the form of an emulsion and are, therefore, more easily digested when taken in reasonable quantities than the fats of other common foods except egg; (*c*) the carbohydrate present in milk (*i.e.*, milk sugar) is easily digestible and has a specific favourable influence upon the bacterial condition in the digestive tract; (*d*) it is a rich source of calcium salts and phosphates ; and (*e*) it is an outstanding source of vitamins A and B_2 and contains some vitamin D. A fairly liberal intake of milk is thus very efficient in supplementing the shortcomings of other food materials composing the dietary. As milk may act as a vehicle for the spread of the germs of definite diseases (such as tuberculosis, typhoid fever. cholera, etc.), it should be pasteurised or raised to the boiling-point (before consumption) to obviate the risk of milk-borne infections. After the boiling point is reached, the milk should be cooled as quickly as possible, since the nutritive value may be seriously affected by prolonged heating and by the unavoidable oxidation which takes place.

Goat's milk is more easily digested than that of the cow and is, therefore, especially suitable to children, invalids and aged people.

Buffalo's milk is very rich in fat, and unless a large amount of the fat is removed, it is not usually suitable for human consumption.

Dahi contains all the constituents of milk except milk-sugar which is partially converted into lactic acid by lactic acid bacilli. It is generally semi-solid and more easily digested than fresh milk, as it has already coagulated into a light and smooth curd.

Skimmed milk (that is to say, milk from which the fat has been removed) and butter milk or "ghol" (which is made by the churning of dahi whereby the fat is removed and is a most valuable food in cases of enfeebled digestion) have a high nutritive value, as, although deprived of vitamin A through the removal of the fat, they retain practically the whole of the proteins, milk sugar, mineral salts and vitamin B_2 found in whole milk.

Condensed milk is the milk condensed or concentrated by boiling off a part of its water-content, and *dried milk* or *milk powder* is milk from which the water has been removed as completely as possible by a process of heating. All the proteins, mineral salts and vitamin B_2 of whole milk remain intact in milk powder, which, when mixed with water, is practically restored to its original condition.

Egg.—The egg is a very valuable food material for human beings on account of its richness in proteins of a high nutritive efficiency, in fats (which are emulsified and, therefore, readily digestible), in compounds of phosphorus and iron and in vitamins A and D. It is also rich in lecithin. The yolk is a much more concentrated food than the egg-white which contains relatively little but proteins and water.

The average weight of a hen's egg is 55 grammes. The duck's egg is larger than that of the hen, the weight of each averaging 70 grammes. About 88 per cent. of an egg is edible, the remaining portion being constituted by the shell.

The digestibility of eggs depends, to some extent, upon the method of cooking, a lightly boiled egg being more easily digested than a hard-boiled or fried one.

Meat.—Meat, like milk and egg, is an admirable source of proteins of good quality. The meat proteins are associated with various water soluble organic substances, conveniently called "extractives" (*e.g.*, creatine, creatinine, etc.), which give meat its appetizing flavour and stimulate the stomach, encouraging it to secrete the gastric juice profusely. Meat is fairly rich in phosphorus and iron and has a variable fat-content. The muscular part is a negligible source of vitamins, except vitamin B_2.

Meat should be eaten in moderation, as an excess of meat-proteins in the diet is susceptible to putrefaction in the intestine, leading to digestive disorders. It should be noted that flesh consists of muscle fibres held together by connective tissue which is chiefly composed of collagen (converted into gelatin on boiling). If the fibres are long and coarse, the meat is less easily digested than when the fibres are short and tender. When there is a large accumulation of fat between the muscle fibres, the gastric juice is prevented from obtaining ready access to them and the digestion of meat is interfered with.

Liver contains proteins of high biological value and is the richest source of vitamin A in the animal body, the liver fats of the sheep, calf or ox containing from 200 to 1,000 times as much vitamin A as a good average sample of butter. It is also rich in a substance which stimulates the formation of red blood corpuscles in the bone marrow. It is richer than muscles in phosphorus and iron. Both the muscle tissue and liver are rich in nucleo-proteins containing purin bases which give rise to an increased excretion of uric acid. Hence such foods should be avoided by the gouty.

Fish.—The proteins of fish, like those of meat, are of a high nutritive value but are less rich in extractives and, therefore, less stimulating than meat proteins. The percentage of fat in different species of fish varies very much. Generally speaking, the fishes are more easily digested than meat owing to the shortness of their fibres. Lean fishes are better borne by the stomach than the fat ones. kai, singbi, magur and other varieties of live fish ("jiol machh," as they are called) contain a very small amount of fat and are, therefore, very nourishing light food given in illness when digestion is impaired. Hilsa, bhetki, bhangan and other kinds of estuarine and sea fishes are among the richest sources of iodine in the dietary.

Vitamin D occurs most richly in the liver of fishes (cod liver oil and halibut liver oil being the richest sources) and throughout the flesh of fatty fishes. Fish liver oils are excellent sources of vitamin A also, and are important sources of iodine.

The much-prized lobster (obtained mostly from estuaries and tidal rivers), although classed popularly as "fish," belongs in reality to the crustacea It is somewhat difficult to digest as the flesh is made up of coarse, dense, and thick-walled fibres.

Dal (*Pulses*).—The chief value of the different kinds of dals lies in the large amount of proteins they contain. Dals possess, pound for pound, an even greater amount of proteins than meat ; but dals as the only source of proteins are not so good as milk, egg, fish or meat. The nutritive value of the proteins of dals are, however, greatly improved when they are taken in combination with those drawn from animal sources. Dals are also rich in phosphorus and iron and in vitamins B_1 and B_2. When they are allowed to germinate, they contain vitamin C also in large amounts. Thus, sprouted gram, peas, etc., form a cheap source of vitamin C.

Dals are not easily digested unless they are properly cooked. They are generally boiled with water and should be cooked in such a way that the grains are lost sight of. When they are soaked in water and ground to a paste and converted into small cakes or balls (called badis) and then cooked, they become easily digestible. "A man cannot digest more than 4 or 5 ounces of dals a day."[1]

Dals contain considerable amounts of nucleo-proteins containing purin bases which are harmful to gouty persons.

Soya Bean.—It has an advantage over other pulses as it contains a higher percentage of proteins (the biological value of which is higher than that of some pulse-proteins) and fats and is richer in mineral salts and vitamins A, B_1 and B_2.

The soya bean forms an important article of diet in China and Japan, and in recent years it is receiving wide attention in India also. The beans cannot be used by themselves on account of their slightly bitter or acrid taste, but they may be consumed in the form of flour (obtained by roasting the beans and then grinding them) after admixture with other pulse-flours, or they may be mixed with common pulses, soaked in water, crushed finely after removal of the skin, converted into small cakes and then cooked. If they are to be widely used in India, considerable attention must be given to their preparation in a palatable form.

Fats and Oils (Butter, Ghee, Mustard Oil, etc.).—Butter consists of the milk-fat taken out from the rest of the milk and is the most acceptable and easily digestible of fatty foods. It is an excellent source of vitamin A and is also an important source of vitamin D.

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[1] "Food"—Robert McCarrison.

Ghee is made by boiling butter at a moderately high temperature. If the butter is boiled in an open vessel exposed to the air, the vitamin A in it is likely to be partly or wholly destroyed ; so care should be taken to conserve its vitamin-content by boiling it in a closed vessel and keeping it as much as possible away from the air. Cow ghee possesses an agreeable flavour and is more highly prized than buffalo ghee.

Butter and ghee are costly articles of diet and are, therefore, beyond the reach of the poor masses who become dependent upon the relatively cheap vegetable oils. Mustard oil is extensively used in Bengal, sesame or teel oil in Madras, and cocoanut oil in Travancore, Ceylon and other places. Their capacity for yielding energy to the body equals that of milk fat, but they are practically devoid of vitamins A and D. If vegetable oils are used instead of butter and ghee, the diet should include other materials from which these vitamins can be secured.

Leafy Vegetables (saks).—The major part of leafy vegetables is water. They contain only a small amount of proteins and carbohydrates and practically no fat, but they owe their importance as regular components of diet to the following facts :—

(*a*) They are a good supplementary source of calcium and a valuable source of other mineral salts, especially potassium salts, which are helpful in balancing the acid-producing tendencies of certain foodstuffs, such as meat, cereals, etc.

(*b*) They are rich in vitamin A or carotene. The easiest and cheapest way of securing vitamin A in good quantity is to take every day a sufficient quantity of green, leafy vegetables which are neither costly nor difficult to obtain. The green leafy vegetables are also among the richest sources of vitamin C.

(*c*) They contain a fair amount of cellulose and therefore supply roughage which stimulates peristalsis and promotes the evacuation of the bowels.

Non-leafy Vegetables.—Most of them contain a good deal of water and do not contribute largely to the total proteins, carbohydrates and fats of the diet. But like the leafy vegetables they are of great value from a dietetic standpoint, because they supply alkaline salts (especially of potassium), vitamins and cellulose. The different vegetables, however, vary widely in value as sources of these ingredients, as may be seen readily from the tables on pages 28-36.

In one form or another vegetables in season appear almost daily in the dietaries of people in this country. The potato holds quite a unique position amongst the vegetables. It is rich in starch and is one of the chief sources from which we obtain our supply of potassium salts. It is also a valuable source of vitamins B_1, B_2 and C. The outer rind of potato is rich in proteins, fats and mineral salts, and we lose these valuable ingredients in peeling it off before cooking. The vitamin C content is also conserved when it is cooked with the skin on. Potato forms a large part of the diet of the Irishman, and its liberal use has been recommended in every country to replace a part of rice or wheat.

Fruits.—Practically every fresh fruit is largely composed of water. The majority of them do not rank high as sources of carbohydrates. Excepting the nuts (*e.g.*, cocoanut, ground nut, etc., which are rich in proteins and fats), they are also relatively insignificant as sources of proteins and fats. Their special nutritive value depends on their organic acids (citric, tartaric and malic acids, for example) and salts (chiefly alkaline salts of organic acids) and their vitamin contents. As the fruits enter the stomach in the raw or uncooked state, they supply the whole of their vitamin contents and vitamin C is best obtained from many fresh fruits which may not contain high concentrations of the vitamin but are still significant anti-scorbutics in the quantities in which they are eaten. Sweet fruits are important dietetic sources of readily assimilable sugars throwing the least burden on the digestive organs. Most fruits are valued also for their mildly laxative effect due to the presence of smooth, soft cellulose. A glance at the tables on pages 28-36 will show, however, that the distribution of the dietary constituents varies markedly in the different fruits.

Of the indigenous varieties of fruits available throughout the year, cocoanut, papaya and banana are the commonest and most highly prized.

Cocoanut.—The fruit is eaten in all stages of development. Like all nuts, it is rich in fats and proteins of fairly high biological value. The kernel of the ripe cocoanut is, however, not readily digestible owing to its compact physical state. The milk, especially of the young nut, forms a palatable and refreshing drink.

Papaya.—It is a most wholesome fruit. The milky juice contains papain which, like pepsin and trypsin, can digest proteins. The papaya should, therefore, prove a boon to sufferers from various forms of indigestion. It is also very useful in piles. The ripe fruit is a very good source of vitamin A. The unripe fruit is used as a vegetable.

Banana.—It is obtainable cheaply at any time of the year and most valuable, when fully ripe, for the high content of easily assimilable sugars (glucose, fructose and cane sugar). " In some portions of Central Africa the nutritious banana is said to be the main article of diet for many, probably scores of millions, of the negro race."

Seasonal Fruits.—Nature offers many varieties of fruits in different seasons of the year. The more common varieties will only be discussed here.

Mango stands pre-eminent amongst seasonal fruits. The ripe fruit is a rich source of vitamin A. For enjoying it out of the season, the fruit is preserved in the form of pickles and the juice is sun-dried and preserved as amsath.

Bael is an excellent fruit and noteworthy for its laxative and other medicinal properties. The unripe fruit is spoken of as being almost a specific for bacillary dysentery ; it is first roasted and then eaten.

Pine apple is rich in organic acids and vitamins and contains bromelin which, like pepsin, is of great value in the digestion of proteins. Pine apple juice, therefore, acts as a general tonic after meals in dyspepsia. The fruit is used also as an anthelmintic.

Citrous fruits (namely, orange, lemon, lime [1] and shaddock or batapi lebu) are rich in vitamin C and in salts of organic acids and serve as alkalinizers tending to establish the acid-base equilibrium of the diet. They also stimulate the secretion of digestive juices and thus help digestion.

Pickles and chutneys made of acid fruits (such as tamarind, raw and green mango, etc.) act in promoting digestion by causing a free flow of the digestive juices and greatly aid in maintaining the alkalinity of the blood. Hence is the great wholesomeness of their use at the end of a meal.

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[1] Kaghzi lebu, Pati lebu and Gonra lebu are different forms of lime.

Fruits of the temperate regions, such as grapes, apples, pears and peaches, are obtained mostly from Kashmir, North-West Frontier Provinces, and Baluchistan and are also imported from foreign countries. These fruits are very popular in every country of the world for their taste, laxative properties and other qualities.

Beverages.—Pure water is the safest and best liquid to drink. Tea, spirituous drinks and other beverages are also in use, but they are not at all necessary for the maintenance of health.

Tea.—Next to water, tea is the beverage most widely in use throughout the world. It is drunk mainly for its stimulating properties. It also satisfies a general demand for some kind of warm drink and forms an agreeable means of drinking a certain amount of boiled (and therefore sterilised) water necessary for nutrition.

In tea infusion, the most important ingredients upon which depends the physiological action of tea are essential oil, caffeine and tannin. Essential oil is one of the chief factors in determining the flavour. Caffeine is a stimulant to the nervous system and has a considerable effect in removing the sensation of fatigue. It is so soluble in boiling water that it is practically all dissolved out of the leaf immediately infusion has begun. Tannin imparts the characteristic astringency to the tea liquor, and during the manufacture of tea it becomes partly oxidised to red and brown colouring substances giving colour to the tea infusion. Tannin in the infusion is the most undesirable part of tea on account of its astringent properties, and especially in large doses it impairs digestion and impedes the action of the bowels. Tea should be infused for as short a time as possible (3 to 5 minutes), for the longer it is infused, the higher is the proportion of tannin dissolved out.

Tea is usually taken with milk and sugar to taste. The addition of milk is to be commended on hygienic grounds, as the albuminous matter of milk throws down some of the tannic acid of the infusion in an insoluble form, and sugar (however small) adds to its nutritive value. When it is carefully converted into a beverage and used in moderate quantities at suitable times, it is harmless to all normal human beings and valuable as a nervous stimulant and restorative in fatigued conditions. The evil effects of tea (*e.g.*, insomnia, giddiness, heart trouble, nervousness, indigestion, etc.) are evident when tea is taken in excess or when it is improperly prepared.

Spirituous Drinks.—The commonly used varieties include beer, pachwai, toddy or tari, and wine (such as port, sherry, etc.), brandy, whisky and rum. The active ingredient in these drinks is ethyl alcohol occurring in varying proportions. Small amounts of bye-products are also associated with ethyl alcohol and serve the purpose of flavouring the alcoholic drinks. The alcoholic beverages are not a necessity for the ordinary healthy individual and should never be used except under medical advice.

ADULTERATION OF FOOD

Some of the common foodstuffs are found to be largely adulterated. Adulteration as commonly practised is the act of debasing a genuine article of food by taking from it one or more of its constituents or by adding to it a cheaper and inferior article so as to increase its weight or bulk, and the customer is defrauded by dishonest dealers who supply an adulterated food in the name of the genuine article for illegitimate profit. The following table will give some idea of the usual forms of fraudulent adulteration as practised in the most important articles of food :—

Food-stuffs	Forms of adulteration
Milk	Addition of water ; abstraction of fat.
Dahi, Chhana ...	Preparation from milk from which the milk-fat has been partially or wholly abstracted. Dahi may also be prepared from milk containing added water.

Foodstuffs	Forms of adulteration
Ghee (clarified butter)	Addition of vegetable oils (*e.g.*, cocoanut oil, groundnut oil, sesame oil, cotton seed oil, etc., which may be hydrogenated and rendered solid) and animal fats (such as beef, mutton and goat fats, lard, etc.) which are at times even obtained from the carcasses of diseased animals.
Butter	Incorporation of excessive amounts of water and foreign fats, such as hydrogenated vegetable oils and animal fats.
Mustard oil ...	Addition of extraneous oil (*e.g.*, oil expressed from ground nut, sesame, poppy seed, sarguja and other oil-seeds).
Wheat flour and Atta	Admixture of maize, rice or other meals of cheaper cereal grains.
Tea	Addition of exhausted tea leaves (*e.g.*, tea leaves already infused).

Foods may also be adulterated by the addition of deleterious substances to them. Some examples of this form of adulteration are given below :—

Foodstuffs	Deleterious adulterants
Milk	Formalin or other injurious preservative substances so as to retain its fresh appearance for a longer period.
Ghee	Mahua, salvadora, castor oil, "white oil" (a bland mineral oil), etc.
Mustard oil	Paka oil (containing a small proportion of hydrocyanic acid), castor oil, mineral oil. etc.
Wheat flour	Fine stone or sand, lime, kaolin, or other minerals.

It will thus be seen that adulteration is objectionable both economically and nutritionally, and adulterated foods also constitute a serious menace to public health, as they may not be so easily digested as the genuine ones and may also be injurious to health when used for their normal purpose. It is often difficult for the customer to judge whether he is getting the genuine articles in the purchase of foods. Legislation was, therefore, introduced (in the shape of the Bengal Food Adulteration Act, which is meant for the whole of Bengal except Calcutta, for which there are special provisions in the Calcutta Municipal Act of 1923) prohibiting the sale of notified articles of food (*e.g.*, milk, dahi, chhana, butter, ghee, mustard oil, wheat flour, atta and tea) which do not comply with the prescribed standards of purity ; in cases of contravention, the penalty imposable is, for the first offence, a fine extending to Rs 200 and for the second or subsequent offence, a fine extending to Rs. 1,000 or imprisonment for three months, or both. The administration of the Bengal Food Adulteration Act is left to Municipalities and District Boards, and for the repression and punishment of food adulteration offences, they must provide adequate staff for effective inspection of food materials and the collection, for purposes of examination in a Public Health Laboratory, of those samples which are suspected to be adulterated, and rigidly enforce all legal provisions. The offenders, when convicted, should be punished to the extent permitted by law so as to produce a deterrent effect. An intensive educational campaign must also be started to educate the public to demand only the genuine articles of food, to avoid unwholesome and fraudulent products and to co-operate with the authorities in bringing the offenders to justice.

FOOD-BORNE DISEASES

Certain infectious diseases, such as cholera, typhoid fever, dysentery, etc., may be transmitted by food, the chief modes of infection being human carriers, infected dust and flies. The problem of the human carrier (that is to say, a person who is apparently in good health but is chronically infected with the organisms of the disease and excrete these organisms) is a difficult one, for he acts as a focus of infection through the handling of food. If, when the carrier is traced, he abstains from the preparation or handling of food and is scrupulously clean in all matters of personal hygiene, the risk of infecting associates will not be serious. The heat of cooking sterilises the food and is, therefore, a safeguard against food-borne infectious diseases (such as cholera and other diseases mentioned previously); cooked foods must also be protected from subsequent infection by dust, flies, etc. Although tuberculosis is largely of human origin, the bovine infection is communicable to young children through the milk of cows which have developed tuberculosis of the udder. Milk should, therefore, be derived from healthy cows living under sanitary conditions. Fortunately, milk is never consumed unboiled in this country, and the destruction of pathogenic organisms which are likely to get into milk is thus ensured.

Foods also become dangerous by infection with a member of the Salmonella group of bacilli (notably, B. aertrycke and B. enteritidis or the Gaertner bacillus), and the bacillus botulinus, and the ingestion of such infected foods may give rise to ill-effects which are spoken of as *food-poisoning*. The great majority of outbreaks of bacterial food-poisoning (which affects numbers of persons who have partaken of food from a common source, become ill at about the same time and exhibit symptoms of a uniform type) result from the ingestion of foods [1] infected with a member of the Salmonella group of bacilli, and the characteristic symptoms are vomiting, diarrhoea, abdominal pain, feverishness, skin eruptions and numbness and cramp in the limbs, and delirium may also occur. The mortality rate is low, not exceeding 2 per cent. of the persons attacked. The common ways in which foodstuffs may be infected are as follows:—

(*a*) The food may be the milk or flesh of an infected animal;

(*b*) Flies may carry the specific bacilli from the faeces of infected animals and human beings to food-materials and thus contaminate them;

(*c*) Rats and mice often suffer from infections of the Salmonella bacilli and their excreta (carrying the bacilli) may contaminate foods;

(*d*) Human carriers may contaminate the food by soiled hands during the process of preparation or serving.

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[1] The majority of the recorded outbreaks have been connected with the use of meat, fish, milk and its products (*e.g.*, cheese and ice-cream); vegetables and cereals are less commonly and fruits rarely implicated.

An important feature is that the infected food is not noticeably altered in appearance, smell or taste. It should be noted that during the process of putrefaction of animal proteins, certain poisonous substances, *viz.*. ptomaines, may be formed ; they are, however, produced in harmful quantities when putrefaction is so far advanced that offensive changes are perceptible to smell, sight or taste, and the loathing excited by the food in such a state is a defence against its consumption. It is not so much putrefying foods as the foods infected by bacteria and their toxins that have caused poisoning. The organisms of the Salmonella group are easily killed by heat, but their toxins are very resistant to heat and would survive most cooking processes. Thus, although thorough cooking greatly diminishes the likelihood of the trouble, it is not always a safeguard against poisoning. The food must also be protected from carriers of bacteria and its contact with hands, knives and receptacles soiled with the bacteria must be prevented. It is also necessary that milk is drawn from healthy cattle and only healthy animals are slaughtered for meat.

The form of food-poisoning caused by the toxin of bacillus botulinus (a spore-bearing anaerobic organism) is called botulism and characterised by ocular disturbances (such as drooping of the eye-lid, squint, dilation of the pupils and impaired vision), partial paralysis of the tongue and throat, progressive weakness and heart failure. The rate of mortality is 60 to 70 per cent. of those attacked. The causative organism is widely distributed in nature, especially in the surface layer of soils, and may thus gain access to fruits and vegetables. The foods responsible for botulism are chiefly preserved meat or meat paste and canned vegetables in which the bacilli have grown and formed toxin. Poisoning arises not from the bacillus, but from the toxin which is produced in foodstuffs before consumption. Fortunately, the toxin is easily rendered harmless by boiling and, therefore, efficient cooking just before serving is an absolute safeguard against poisoning. In some cases signs of physical deterioration (*e.g.*, gas formation, rancid odour, etc.) give warning that spoilage has occurred, and such a food should be totally discarded.

MEALLIC CONTAMINATION

Foods may be contaminated with poisonous metallic compounds derived either from the materials used in their manufacture, or from the utensils used for their preparation or storage.

Arsenic is the most dangerous metal likely to be encountered in foodstuffs. Glucose syrup, jams containing glucose, beer, baking powder, vinegar and cocoa are examples of foods which are liable to contain arsenic through the use of arsenical sulphuric acid in their manufacture or through the use of ingredients prepared with arsenical sulphuric acid. It is necessary for the manufacturers to take suitable precautions against such contamination.

Lead, tin or copper may sometimes be found in foods, being derived from the containers made of these metals, and foods (particularly, acid fruits and liquids) should never be left standing in them for any length of time.

CHAPTER IV

PLANNING OF CHEAP BALANCED DIETARIES

In the foregoing chapters we have briefly considered the dietary constituents first from the qualitative and then from the quantitative aspect and have summarised the dietary value of the common food-stuffs. We are now in a position to construct sound dietaries consisting of a number of foodstuffs. It will be noted that the function of the diet is threefold : it pleases the palate, satisfies the appetite and supplies the materials for proper nutrition, inducing the highest development of health, happiness and efficiency which native endowments make possible. If the diet is to fulfil all its functions, it must be a balanced one. A balanced diet depends upon many factors :—

It must have a sufficient caloric value, that is to say, the amount ingested must cover the energy requirements of the consumer ; it must contain the correct quantities of proteins (which should include a certain amount of animal proteins of high biological value), carbohydrates (starch and sugar) and fats in an easily digestible form, and provide all the vitamins and all the necessary mineral salts as well as water in adequate amounts ; it must contain a reasonable amount of the indigestible residue, such as cellulose, which gives bulk to the diet, stimulates intestinal movement and promotes defaecation ; it must take into account the acid-base equilibrium (*i.e.*, the acid-formers should be judiciously combined with alkali-producers) ; and it must be palatable. Most foods are unpalatable and difficult of digestion if eaten raw, but are softened so as to be easily masticated and converted into easily digestible forms after they are properly cooked. Good cooking with a judicious admixture of oils or fats and a variety of condiments [1] renders the food materials palatable and pleasing to the eyes and to the sense of smell. Palatability and attractiveness of well-cooked foods are important factors for evoking the flow of digestive juices and, therefore, for the digestion and assimilation of the food, and consequently, contribute to nutritional well-being. Another purpose of cooking is to destroy micro-organisms and certain noxious products through the heat, and the food is, therefore, rendered safe so far as these dangers are concerned.

We rely on some cereal grains (rice, wheat, etc.) for the main bulk of the diet. Of all the cereal grains, rice grows best in Bengal. It is easily obtainable and cheap enough to be within the reach of all classes of the community. Consequently, it forms the basis of the national diet of the Bengalis. Modern developments in transport facilities are enabling the people (particularly the townspeople) to take advantage of an abundant supply of cheap wheat also. One may take it as a golden rule that a diet may quite satisfactorily consist of food materials which are easily obtained and relatively cheap (*e.g.*, rice, wheat flour or atta, dal, etc.) if it is sufficiently supplemented by protective foods (that is to say, the foodstuffs which are valuable for providing good proteins, mineral salts or vitamins in which the principal foods are deficient and thus prevent characteristic ailments due to nutritional defects), such as milk, green leafy vegetables and fresh fruits. Fish, meat and egg are also among the protective foods. These foods are consumed by people all over the province, but the quantities consumed vary with their economical condition. When the amounts of different foodstuffs composing the diet are known, we can assess its nutritive value by a reference to the tables on pages 28-36 and determine the extent to which it falls below the desirable standards. Adjustments might then be made in the diet so that it may satisfy fully the nutritional needs. We will now consider how sound dietaries can be arranged in the cheapest possible way. It must be remembered that the amount of food required by an individual varies with his height, weight, age, sex, the amount of work performed and other factors. It is, therefore, impossible to construct a dietary which will be ideal for all persons.

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[1] It must be remembered that when large amounts of oil or fats are used in cooking, they form a coating over the food materials and thus retard their digestion unduly. Excessive use of the spices also is harmful to the digestive organs and checks the secretion of digestive juices.

DIETARY SCHEME FOR AN ADULT PERSON, MALE OR FEMALE

As has already been noted in Chapter II, a balanced diet for an adult man or an adult woman (other than an expectant or nursing mother) must supply daily sufficient amount of proteins (at least 1 gramme of proteins for every kilogramme of the individual's body weight, about one-third [1] of the total proteins being derived from animal sources), fat (about 70 grammes,[2] the quantity which can be advantageously ingested depending upon the individual's power of digestion, energy-expenditure, etc.) and carbohydrates (as needed to make up the energy requirements of the individual), 0·75 gramme of calcium, 1·5 gramme of phosphorus, 20 milligrammes of iron and all the vitamins in abundance. It must also fulfil the other requirements as shown on pages 83-84.

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[1] Proteins of animal origin are more costly than those drawn from vegetable sources. It should be remembered, however, that some animal proteins are better than none, since they are not only themselves of high nutritive value but also increase the biological value of inferior proteins and thereby render them of greater value in nutrition than they otherwise would be.

[2] It is worthy of note that the addition of some vegetable oils at the expense of a quantity of rice of equal caloric value does not greatly increase the cost of the diet.

Diet No. 1—Specimen lacto-vegetarian diet (for a well-proportioned adult man who is 160 centimetres or about 5′ 3″ in height and 70 kilogrammes or about 154 lbs. in weight) providing 3,000 Calories gross.

There are some people in Bengal (*e.g.*, Vaishnavas, Jains, Buddhists, ascetics and widows of a few castes, such as Brahmins, Baidyas, and Kayasthas) who do not take fish, meat or egg. Milk (or its products, such as dahi, skimmed milk, etc.) is the only source of animal proteins in their diet. Milk not only supplies proteins of good quality but is also an important source of fat, mineral salts and vitamins. A lacto-vegetarian diet at a minimum cost may be devised in the following manner :—

TABLE I

Lacto-Vegetarian Diet

(The estimates are based on data supplied in the tables on pages 28-36)

Food-stuffs	Amount	Proteins		Fats	Carbo-hydrates	Cal-cium	Phos-phorus	Iron	Vitamins				Calories (approxi-mately)	Cost (at retail rates at Calcutta)*
		Total	Animal						A	B₁	B₂	C		
	(Ounces)	(Grammes)							International Units			Milli-grammes		
														Rs. a. p.
Rice, home-pounded (1)	18	43	...	1·8	401	0·03	0·7	0·01	...	500	Poor	...	1,840	0 1 0
Dals, unsprouted (2) (average)	2	11	...	0·5	32	0·04	0·1	0·001	36—260	50—100	Good	...	180	0 0 1½
Fresh and green leafy vegetables (calculated as spinach) (3)	4	0·5	...	...	0·5	0·07	0·01	0·004	3,000	80	Good	56	5	0 0 1½
Non-leafy vegetables (4)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Milk, whole ...	25	23·5	23·5	25	35	0·75	0·5	0·001	1,275	...	Rich	...	470	0 2 9
Gur	1	...	...	...	27	0·02	0·01	0·003	80	...	...	...	110	0 0 1
Mustard oil ... (5)	1½	...	...	42·5	...	...	...	...	...	...	...	...	395	0 0 4½
Fresh fruits (*e.g.*, guava, lemon, lime, lichi, orange, papaya, pine-apple, plum, shaddock or other fruits of the season) (6)	...	...	...	...	...	...	...	...	...	...	...	To yield about 30	...	0 0 3
Tentul, salt and spices...	...	...	...	...	...	...	...	...	...	...	...	...	...	0 0 1
Total ...	...	78·1	23·5	69·8	495·5	0·91	1·32	·019	Over 4,300	Over 600	Ade-quate	Over 80	3,000	0 4 9½

* Owing to seasonal variations of the prices of food-stuffs the total cost is variable. The average price is only given.

(1) When dhenki-husked or lightly milled rice is used and it is cooked in such a way that the necessity of

pouring off the gruel does not arise, or even when the gruel is poured off, it is not thrown away but is consumed, enough of vitamin B_1 is usually obtained. Parboiled rice, even when milled, is superior in nutritive value (particularly as regards vitamin B_1) to raw rice, milled to the same degree; but if the gruel is drained off after cooking and thrown away, other food materials will have to be eaten with rice so as to make good the deficiency of vitamin B_1. The simplest way of guarding against the risk of a shortage of vitamin B_1 is to replace half of the quantity of rice by whole wheat flour or atta which also increases the amount of proteins and mineral salts without increasing the cost of the diet.

(2) The different kinds of dals are interchangeable in the dietary without great alterations in the price and food value.

(3) We lack at present the precise knowledge of the amount of carotene or vitamin A in the different leafy vegetables in season. It may be assumed, however, that all green leafy vegetables are richly endowed with carotene, their greenness being a good rough indication of carotene-content.

(4) The use of potatoes has been advocated to replace part of cereals in the ordinary diet. If advantage is taken of the seasonal cheapness, other vegetables of the season may also be introduced into the menu at no great expense; but they are not absolutely necessary if the diet includes a liberal amount of green leafy vegetables.

(5) Pure ghee or butter is preferable to vegetable oils but is very much dearer.

(6) Some fruits (*e.g.*, mango, papaya, orange, tomato, etc.), when ripe, become good sources of vitamin A also.

The table on page 88 gives an example of a well-balanced diet, the food materials being consumed in three or four meals. As stated previously, an adequate intake of water should be a regular habit. If adult requirements of vitamins A and B_1 are reckoned at 2,000-4,000, and 300 International Units respectively, and of vitamin C as 30-50 milligrammes, sufficient margin is left for losses on cooking. Vitamin D is inadequately supplied in this diet, as the ideal method of providing natural foods rich in this vitamin is not economically possible, but a sufficient exposure of the body to sunshine for some period each day will compensate for the inadequate intake of this vitamin. Where climatic conditions or social customs (*e.g.*, observance of the purdah system) do not permit of exposure to sunshine, vitamin D should be supplied in the form of cod liver oil or other fish liver oils rich in vitamin D. So far as vitamin E is concerned, its wide distribution among foods makes it probable that in any case a dietary good in other respects would practically always supply enough of this vitamin. This dietary can be modified in many particulars, as in many cases alternative sources exist from which to secure the requisite ingredients. In fact, one may eat such foods as one may fancy within the limits of one's digestive and purchasing capacities, provided the principles of dietetics are duly observed. The dietary should also be varied moderately from day to day, to avoid the repugnance which would inevitably follow the prolonged ingestion of a monotonous diet. It is also essential that the food-stuffs are drawn from as wide a variety of sources as possible, because the more varied the diet, the greater the probability that all the necessary constituents are present in sufficient amounts. The peculiar sensitiveness termed idiosyncrasy shows itself in certain persons in the form of intolerance to certain articles of food (*e.g.*, egg, cheese, lobster, crab, etc.) which are perfectly wholesome and have no ill effect on the great majority of people. A person suffering from this susceptibility may be made acutely ill by eating a small quantity of the special food to which he is intolerant. The more usual symptoms which occur in these cases are of three kinds: (1) gastro-intestinal irritation, as shown by nausea, vomiting and diarrhoea ; (2) skin irritation resulting in rashes of the urticarial and erythematous types and eczema ; (3) asthmatic attacks.

The net value of food is to be assessed not by the amount consumed but by the amount which can be digested, absorbed and assimilated. In order that the digestive system may fulfil its function efficiently, the meals should be taken at regular times, the foods should be skilfully prepared so as to render them as appetising as possible (but their digestibility and nutritive value must not be impaired by faulty methods of cooking) and nicely served, and they should be reduced to very small particles by thorough mastication, the amount of food consumed at a single meal must be well within the individual's digestive capacity, and the number[1] of meals should be arranged in such a manner that the stomach and the intestines have a rest of some duration between meals. It is a good thing to have a short rest before a meal as well as afterwards. Worry, anxiety, fear and anger act as marked inhibitors of the digestive juices ; hence is the necessity of peace and contentment, a contented mind being a great asset towards perfect health. Abundance of fresh air and sunshine, regular and moderate physical exercise, and regular intervals of rest and sleep are also essential for the proper digestion and utilisation of foods. Finally, the metabolic processes of the body are markedly influenced by the cooling power of the atmosphere, and the coolness which is pleasant and comfortable and conducive to our health and well-being is created by certain combinations of temperature, relative humidity[2] and air movement. It should be noted that the body, in doing muscular work and in digesting food, manufactures more heat than is needed to maintain itself at the normal temperature (around 98 degrees, Fahrenheit). It is essential to the health and comfort of mankind that this surplus heat is easily got rid of. When the temperature of the air is much below 98 degrees, the body quickly loses heat by radiation and convection ; but it must always keep up its own heat, the temperature equilibrium being maintained by increased heat production within the body through the acceleration of metabolic processes. The augmented metabolism leads to increased digestion and assimilation, and improves nutrition and thus promotes health. Loss of heat by radiation and convection diminishes as the temperature of the air rises, and ultimately ceases when the air temperature reaches that of the body. A good deal of the bodily heat is also removed by the evaporation of moisture from the skin and lungs, the amount of evaporation being dependent upon the relative humidity of the atmosphere. Moderate cooling by evaporation is necessary for continued health and vigour. It should not be excessive, although the healthy body can stand a great strain. When the temperature of the air reaches or exceeds that of the body but the relative humidity is low, evaporation of moisture from the skin and lungs is rapidly promoted and the body is consequently cooled. When, however, the atmospheric temperature and relative humidity are both high, evaporation is retarded and the cooling of the body by this process is diminished. We, therefore, feel far less comfortable on hot and damp[1] days, due to body heat stagnation, than on drier days of similar temperature. In cool and dry air, the loss of heat by radiation and convection is reinforced by that due to evaporation. A damp climate, however, becomes physiologically dry when it is cool, because the cool air is very much warmed on coming in contact with the body, and its relative humidity (which decreases with increasing temperature), therefore, falls to a much lower percentage than that of the warmer air with the same degree of relative humidity. Prof. Ellsworth Huntington[2] maintains that a climate in which the midday temperature rises to 70 degrees (Fahrenheit) more or less, and the night or minimum temperature falls below 55 degrees, and the relative humidity averages 80 per cent., is the most favourable for health. The ideal climate must also have frequent small changes of temperature and relative humidity from day to day. Moving air makes any ordinary condition feel cooler by increasing the loss of heat by both convection and evaporation, the cooling power of the air being greatest when it is cold and dry and in rapid movement. When the temperature of the air is little below that of the body and the air is almost saturated with water vapour and is comparatively still, the loss of body heat either by radiation and convection or by evaporation is greatly reduced and oppressive feelings arise from body heat stagnation, and as there is little call made upon the heat-producing powers of the body, metabolism is decreased, digestive and assimilative powers weakened and nutrition diminished. The climate of Bengal is characterised by great heat associated with high relative humidity during the greater part of the year (from the middle of March to the end of October) ; the air is, however, relatively cold and dry during the period from November to February. Consequently, many people appreciate the necessity of spending part of the year in a more pleasant and stimulating climate so as to be refreshed and invigorated. The value of a change of air has been recognised from time immemorial, but it is still mainly regarded as a luxury for the well-to-do. In Bengal, those of us who can afford it usually resort to Madhupur, Deoghar, Giridih, Hazaribagh, Ranchi and other places in the cold weather months when the climate in these places is cool, dry and pleasant and very healthy. In the hot weather months, the hill stations (*e.g.*, Darjeeling, Shillong, etc.) attract many holiday-makers from the sweltering and steamy heat of the plains, and as the coolness and other valuable factors of the climate of hill resorts stimulate the digestive organs to a greater activity, the whole system is generally toned up and a feeling of well-being is created. We also visit the sea-shore for a change of air. Puri is a well-known sea-side resort remarkable for the equability of its temperature and relatively pure and dust-free air; besides, the wind has free play and brings air off the sea containing salt, traces of iodine and other constituents of sea water.

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[1] It is wise to eat one good meal in the day and another good meal in the night, and to make any meal taken in the early morning and afternoon very light. Nothing should be eaten between meals except water.

[2] Relative humidity is expressed as the percentage of the amount of water vapour which would be just necessary to cause saturation. When the air is quite saturated, its relative humidity is said to be 100 per cent.

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[1] In a general way, it is often stated that when the relative humidity is low, the air can take up large amounts of water vapour and would feel "dry," but its capacity for absorbing additional moisture becomes less and less as the relative humidity increases, and when it approaches 100 per cent. the air feels "damp."

[2] "Civilization and Climate"—Ellsworth Huntington.

Diet No. 2—Specimen lacto-vegetarian diet providing 3,000 Calories gross

Diet No. 1 includes whole milk. It will be noted that milk is a very costly item of diet at Calcutta but is relatively cheap in smaller towns and villages. Whole milk can be replaced by skimmed milk or skimmed milk powder (which, though not produced in India at the present time, is available in large cities at a much less cost), which supplies the proteins and mineral salts of the whole milk but is deficient in fat and vitamin A.[1] The shortcomings of skimmed milk are, therefore, to be corrected by a rational arrangement of the diet as follows:—

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[1] As stated on page 13, red palm oil is very rich in carotene and is thus a valuable potential source of vitamin A. It is obtained from the fruit of the palm known botanically under the name of elaeis guineensis (which is chiefly cultivated in Africa and has also been grown in Malaya and Burma). The oil shipped in bulk from Singapore can be obtained in India at a cost which works out at about 2½ annas per pound. The oil cannot be consumed as such owing to its undesirable taste and smell. But when small quantities of the oil are mixed with mustard oil or other vegetable oils, the mixture becomes palatable and has been recognised as a cheap and effective means of making good the deficiency of the diet in vitamin A.

TABLE II

Lacto-Vegetarian Diet

(The estimates are based on data supplied in the tables on pages 28-36)

Food-stuffs.	Amount	Proteins		Fats	Carbo-hydrates	Cal-cium	Phos-phorus	Iron	Vitamins				Calories (approximately)	Averge cost (at retail rates at Calcutta)
		Total	Animal						A	B₁	B₂	C		
	(Ounces)	(Grammes)							International Units			Milli-grammes		
														Rs.a.p.
Rice, home-pounded ...	18	43	...	1·8	401	0·03	0·7	0·01	...	500	Poor	...	1,840	0 1 0
Dals, unsprouted ... (average)	2	11	...	0·5	32	0·04	0·1	0·001	36—260	50—100	Good	...	180	0 0 1½
Fresh and green leafy vegetables (calculated as spinach).	6	0·9	...	...	0·8	0·1	0·015	0·006	4,500	120	Good	84	7	0 0 2½
Skimmed milk powder†	2¼	24·0	24·0	...	32	0·8	0·6	Trace	0	100	Rich	...	230	0 0 9
Gur ...	1	...	...	...	27	0·02	0·01	0·003	80	...	...	...	110	0 0 1
Mustard oil ...	2½	...	...	71	...	...	...	...	...	...	...	...	660	0 0 7½
Fresh fruits of the season.	...	...	...	...	...	...	...	...	...	...	...	To yield about 30	...	0 0 3
Tentul, salt and spices	...	...	...	...	...	...	...	...	...	...	...	...	...	0 0 1
Total ...	...	78·9	24	73·3	492·8	0·99	1·425	·02	Over 4600	Over 700	Adequate	Over 100	3,027	0 3 1½

† To reconstitute the milk, 1 part of milk powder is dissolved in about 7 parts of warm water, and the mixture is next boiled for a few minutes. This mixture is approximately of the same strength as fresh skimmed milk but is more easily digested, as the curd produced during digestion is more finely divided Milk powder is mostly imported from New Zealand in tins of 56 pounds and costs Rs. 16-8-0 per tin.

Skimmed milk, when available, may replace skimmed milk powder in the dietary.

Diet No. 3—Specimen non-vegetarian diet providing 3,000 Calories gross

In the case of non-vegetarian diets, animal proteins may be derived from fish, meat or egg. 24 grammes of proteins are obtainable from about 6 ounces of fish, 4½ ounces of meat or 3 duck's or 4 hen's eggs. This amount of proteins may also be derived from about 25 ounces of milk. The following table shows the prices of these food materials and the chief nutritive ingredients contained in them :—

Nutritive ingredients	Fish (6 ounces)	Meat (4½ ounces)	Duck's egg (three)	Milk (25 ounces)
Proteins (in grammes)	24	25	24	24
Fat (,,)	1	3	24	25
Carbohydrates (,,)	...	...	...	35
Calcium (,,)	0·12	0·018	0·12	0·75
Phosphorus (,,)	0·48	0·27	0·45	0·5
Iron (,,)	0·002	0·002	0·003	0·001
Vitamins—				
A ...	Poor	Poor	Rich	Rich
B_1 ...	Poor	Poor	Good	Good
B_2 ...	...	Good	Rich	Rich
C ...	...	...	...	Poor
D ...	...	Poor	Poor	Poor
Cost at retail rates at Calcutta.	6 pice	5 pice	4½ pice	11 pice

It will be seen that milk is the most costly article supplying proteins of good quality; but as it is associated with larger amounts of fats, calcium, phosphorus and vitamins, it is the one article of food for which there seems to be no satisfactory substitute. Without milk it is unlikely that the diet will contain enough calcium for the best nutrition. Milk in some form should, therefore, be a part of the diet at all ages.

It is sensible to buy eggs which supply cheaply not only proteins but also other important nutrients at the same time. It is, however, important to remember that the proteins of egg, like those of meat, are readily susceptible to putrefaction in the large intestine. If animal proteins are daily supplied solely in the form of egg or meat, there would be digestive disturbances. Fish can, however, be used as the sole source of animal proteins and may also be partially replaced by meat or egg unless there is definite individual reason to the contrary. We cannot, however, dispense with milk for its valuable qualities. A non-vegetarian diet may be economically planned in the following manner :—

TABLE III

Non-Vegetarian Diet

(The estimates are based on data supplied in the tables on pages 28-36)

Food-stuffs	Amount	Proteins		Fats	Carbo-hydrates	Calcium	Phosphorus	Iron	Vitamins				Calories (approximately)	Average cost (at retail rates at Calcutta)
		Total	Animal						A	B₁	B₂	C		
	(Ounces)	(Grammes)							International Units			Milli-grammes		Rs. A. P.
Rice, home-pounded	18	43	...	1·8	401	0·03	0·7	0·01	...	500	Poor	...	1,840	0 1 0
Dals, unsprouted (average).	2	11	...	0·5	32	0·04	0·1	0·001	36—200	50—100	Good	...	180	0 0 1½
Fresh and green leafy vegetables (calculated as spinach)	4	0·6	...	...	0·5	0·07	0·01	0·004	3,000	80	Good	56	5	0 0 1½
Milk, whole	16	15	15	16	22	0·5	0·3	0·001	815	...	Rich	...	300	1 9
Fish *	2	8	8	0·4	...	0·04	0·15	Trace	...	...	...	...	35	0 0 6
Gur	1	...	...	...	27	0·02	0·01	0·003	80	...	...	...	110	0 0 1
Mustard oil	2	...	...	56·8	...	...	...	...	...	...	...	...	530	0 0 6
Fresh fruits of the season.	...	...	...	...	...	...	...	...	...	...	...	To yield about 80	...	0 0 3
Tentul, salt and spices	...	...	...	...	...	...	...	...	...	...	...	...	...	0 0 1
Total ...	...	77·6	23	75·5	482·5	0·7	1·27	·019	Over 3,000	Over 600	Adequate	Over 80	3,000	0 4 5

* Fish may be replaced by meat or egg giving an equivalent amount of proteins.

Diet No. 4—Specimen non-vegetarian diet providinq 3,000 Calories gross

Diet No. 3 includes whole milk which may be replaced by skimmed milk powder as in Diet No. 2. A cheap non-vegetarian diet may be arranged in the following manner:—

TABLE IV

Non-Vegetarian Diet

(The estimates are based on data supplied in the tables on pages 28-36)

Food-stuffs	Amount	Proteins		Fats	Carbo-hydrates	Cal-cium	Phos-phorus	Iron	Vitamins				Calories (approximately)	Average cost (at retail rates at Calcutta)
		Total	Animal						A	B₁	B₂	C		
	(Ounces)	(Grammes)							International Units			Milli-grammes.		
														Rs.a.p.
Rice, home-pounded ...	18	43	...	1·8	401	0·03	0·7	0·01	...	500	Poor	...	1,840	0 1 0
Dals, unsprouted (average)	2	11	...	0·5	32	0·04	0·1	0·001	36—260	50—100	Good	...	180	0 0 1½
Fresh and green leafy vegetables (calculated as spinach).	6	0·9	...	...		0·1	0·015	0·006	4,500	120	Good	84	7	0 0 2½
Skimmed milk powder	1½	16	16	...	21	0·6	0·4	Trace	0	70	Rich	...	150	0 0 6
Fish ...	2	8	8	0·4		0·04	0·15	Trace	...	...	...	...	35	0 0 6
Gur ...	1	...	...	...	27	0·02	0·01	0·003	80	...	...	...	110	0 0 1
Mustard oil ...	2½	...	...	71	...	...	...	...	...	...	...	...	660	0 0 7½
Fresh fruits of the season.	...	...	...	...	...	...	...	...	...	...	...	To yield about 30	...	0 0 3
Tentul, salt and spices	...	...	...	...	...	...	...	...	...	...	...	...	...	0 0 1
Total ...	...	78.9	24	73·7	481·8	0·83	1·375	0·02	Over 4,600	Over 700	Adequate	Over 100	2,982	0 3 4½

The foregoing dietary schedules have been designed to supply the requirements of an adult man who is 160 centimetres in height and 70 kilogrammes in weight and does external work involving an expenditure of 940 Calories. The energy requirement of a man engaged in work is in fact dependent on the nature of the work and the length of time he is engaged in such work. The average Bengali adult man, 160 centimetres tall, weighs about 120 pounds (about 54 kilogrammes), and his surface area, therefore, corresponds to about 1·55 square metres; if such a man does external work involving an energy output of 940 Calories, he requires daily an intake of food with a Calorie value of about 2,800. If he is to work very strenuously, he must have a correspondingly high Calorie intake; but when he is following sedentary occupations, he would require an intake of food with an energy value of some 2,200 Calories. The dietaries (Nos. 1, 2, 3 and 4) described previously are, therefore, to be modified to suit the needs of the individual in the following manner:—

SPECIMEN DIETS (Nos. 5-8) PROVIDING ABOUT 2,200 CALORIES.

Foodstuffs	Diet No. 5 Lacto-Vegetarian		Diet No. 6 Lacto-Vegetarian		Diet No. 7 Non-Vegetarian		Diet No. 8 Non-Vegetarian	
	Quantity (Ounces)	Cost (at retail rates at Calcutta)	Quantity (Ounces)	Cost (at retail rates at Calcutta)	Quantity (Ounces)	Cost (at retail rates at Calcutta)	Quantity (Ounces)	Cost (at retail rates at Calcutta)
		Rs. a. p.		Rs. a. p.		Rs. a. p.		Rs. a. p.
Rice	12	0 0 8	12	0 0 8	12	0 0 8	12	0 0 8
Dal	1	0 0 ¾	1	0 0 ¾	1	0 0 ¾	1	0 0 ¾
Fresh and green leafy vegetables (calculated as spinach).	4	0 0 1½	6	0 0 2½	4	0 0 1½	6	0 0 2½
Milk (whole) ...	20	0 2 3	...	...	16	0 1 9	...	...
Skimmed milk powder.	...	...	1¾	0 0 7	...	...	1¼	0 0 5
Fish	...	...	...	...	1	0 0 3	1	0 0 3
Mustard oil ...	1½	0 0 4½	2¼	0 0 7	1½	0 0 4½	2¼	0 0 7
Gur	1	0 0 1	1	0 0 1	1	0 0 1	1	0 0 1
Fresh fruits of the season to supply about 30 milligrammes of vitamin C.	...	0 0 3	...	0 0 3	...	0 0 3	...	0 0 3
Tentul, salt and spices	...	0 0 1	...	0 0 1	...	0 0 1	...	0 0 1
Total cost... ...	...	0 3 10¾	...	0 2 6¼	...	0 3 7¾	...	0 2 7¼

Outside Calcutta, the prices of food articles vary from place to place and the substitution of one article of food for another in the menu may be necessary to plan a balanced diet at a minimum cost. In the villages the different food-stuffs are much cheaper than in towns, and the expenditure on food becomes much less. Moreover, almost every family in our villages has a homestead with a small parcel of land and a tank attached to it. It is thus fairly easy for the villagers to grow different varieties of seasonal vegetables and fruits, to raise fish in the tank and to rear poultry and cows at a little cost and are thus in a position to arrange sound dietaries at a greatly reduced expense. The urgent need at the present time is the formulation of methods by which the production of "protective foods" can be greatly increased and their consumption encouraged.

Diet No. 9—Specimen diet (for an adult woman who is 155 centimetres in height, and 55 kilogrammes in weight) providing 2,400 Calories gross.

The dietary can be constructed (on lines similar to those followed in the case of adult men) by first attending to the requirements of proteins (including animal proteins), fats, mineral salts and vitamins, and then including in the diet sufficient quantities of carbohydrates, to make up the individual's energy needs.

DIET OF EXPECTANT AND NURSING MOTHERS

The expectant or nursing mother provides to the foetus or the suckling the nutrients which cause a large drain on her own supplies unless she is receiving an abundant amount in her food. Her needs in regard to certain food constituents, such as good proteins, calcium, phosphorus, iron, iodine and vitamins are in fact far greater than those of the non-pregnant and non-lactating woman. If she is inadequately fed, she has to sacrifice her own valuable stores in partially meeting the needs of the developing off-spring, with the result that both of them become victims of under-nourishment, the effects of which are to be seen in the physical inefficiency and ill-health of the mother and defective development and diminished resistance to infections of the foetus and infant. Wise feeding during gestation and lactation not only keeps the mother in good health but also ensures adequate physical endowment for the child at birth and the presence in the mother's milk of a good supply of all the essentials for her infant's optimum nutrition, and normal growth and development. As stated previously on page 47, a pregnant or nursing woman should receive 2 grammes of proteins for every kilogramme of body weight and a large portion of the total proteins should be of animal origin. An extended dietary use of whole wheat flour (atta) to replace part of rice in he ordinary diet, a liberal intake of milk (about 2 pints per day), a sufficiency of green leafy vegetables and fresh fruits, and the use of glandular organs (liver and kidney which are sources of good proteins and carriers of vitamin A) and sea-fish (to supply proteins of good quality as well as iodine) at short intervals are usually advised in the diet throughout pregnancy and lactation. In goitrous regions where sea-fish is not available, the provision of extra iodine in the form of iodised salt (that is to say, common salt or sodium chloride containing 1 part of sodium iodide in 200,000 parts of sodium chloride) or in some other way is necessary. The foods should be plainly and daintily cooked with a due admixture of oil or fat and the various spices. As ordinary diets are usually inadequate in vitamin D, the pregnant and nursing woman must bask in the sun for some time each day, and when there is lack of sunshine, she must take daily about 3·5 grammes of cod liver oil (which ensures a good supply of vitamin D as well as vitamin A) in order to make up for any lack of sunlight. The following specimen diet for a pregnant or nursing woman works out at about 2,400 Calories :—

TABLE V

(The estimates are based on data supplied in the tables on pages 28-36)

Foodstuffs	Amount	Proteins		Fats	Carbo-hydrates	Cal-cium	Phos-phorus	Iron	Vitamins				Calories (approximately)	Average cost (at retail rates at Calcutta)
		Total	Animal						A	B₁	B₂	C		
	(Ounces)	(Grammes)							International Units			Milli-grammes		
Rice, home-pounded ...	6	14	...	0·6	134	0·01	0·2	0·003	...	165	Poor	...	615	Rs-A.P. 0-0-4½
Atta ...	6	20	...	2	122	0·08	0·5	0·006	180	395	Poor	...	600	0-0-4½
Dals, unsprouted (average).	1	5·5	...	0·2	16	0·02	0·05	Trace	18—130	25—50	Good	...	90	0-0-¾
Fresh and green leafy vegetables (calculated as spinach).	4	0·6	...	...	0·5	0·07	0·01	0·004	3,000	80	Good	56	5	0-0-1½
Milk, whole ...	32	30	30	32	44	1·0	0·6	0·002	1,680	...	Rich	...	600	0-3-6
Egg (one) ...	2	7	7	7	...	0·03	0·1	0·001	680	...	Rich	...	95	0-0-4½
Fish ...	4	16	16	0·8	...	0·18	0·3	Trace	...	...	...	...	70	0-1-0
Gur ...	1	...	...	...	27	0·02	0·01	0·003	80	...	...	...	110	0-0-1
Mustard oil ...	¾	...	...	21	...	...	...	...	...	...	...	...	195	0-0-2¼
Fresh fruits of the season.	...	...	...	...	...	...	...	...	...	...	...	To yield about 30	...	0-0-3
Tentul, salt and spices	...	...	...	...	—	...	...	...	...	...	...	...	...	0-0-1
TOTAL ...	...	93·1	53	63·6	343·5	1·31	1·77	·019	Over 5,500	Over 600	Adequate	Over 80	2,380	0-6-5

Diet of Infants

Infants are to be properly fed not only to pilot them safely through the perils of the first year of life but also to lay the foundation of healthy and vigorous manhood and womanhood. Tissues and organs of the body are often badly constructed if the essential dietary constituents are not adequately supplied during the earliest years of life. Some of these defects are not only serious but may even be irreparable in later life even by the most perfect diet.

The mother's milk is the natural food perfectly nourishing and digestible for the baby and also contains protective substances (called "anti-bodies") which, being transferred from the mother to the infant, increases its resistance towards those diseases to which the mother is more or less immune. It is impossible to satisfactorily replace the breast milk by that of another species. Breast-feeding is, however, dependent largely upon the care the mother takes of herself regarding her diet, etc. Every nursing mother must be rationally fed for the continuation of an abundant milk secretion, for ensuring the presence in her milk of a good supply of all the essentials for the infant's health and development and for the maintenance of her own health. She should feed the baby at definite intervals so that its stomach may have regular periods of rest and proper habits are formed early. Very small or weakly babies should be fed every three hours and bigger babies every four hours between 6 a.m. and 6 p.m. During the early weeks of life two night nursings may be needed, but as soon as possible not more than one night nursing at about 10 p.m. should be given. If the baby wakes in the night and cries, plain boiled water may be given in a spoon. Water should also be given to the baby three or four times a day half-way between two feedings ; it should be warmed to the body temperature (about 98° F) and used in quantities of 1 to 2 ounces at a time. All infants should also receive juices of fresh fruits (*e.g.*, orange, lemon, tomato, etc.) between feeds (say, at 4-30 p.m.) to provide 5 to 15 milligrammes of vitamin C. It is also a sound policy to expose them to sunshine for some periods daily to develop vitamin D (inadequately supplied through the intake) in their bodies. When they are not exposed to sunshine, or whenever abundant sunshine is not available, it is advisable to include in the diet of every infant about 3 grammes (which should be gradually increased to 6 grammes) of cod liver oil of good quality to supply additional amounts of vitamins A and D and iodine. The baby should not be given any untimely food. The mother must not, therefore, force the baby to take the breast in order to appease it whenever it cries or is fretful from any cause ; a neglect of this rule results in the creation of a morbid appetite and leads to digestive troubles. Regular weekly weigh ings should be carried out, as a steady regular gain in weight is an indication that the baby is getting adequate foods to satisfy its needs. The baby at birth is from sixteen to twenty inches long and ought to weigh from six to eight or nine pounds. The length is normally increased by about 1 inch each month for the first four months and by about ½ inch each month from the fifth to the twelfth month, and the birth weight should be doubled in six months and trebled when the baby is 12 months old. The baby cannot thrive properly if it gets insufficient food or is unable to digest the food it is taking.

When the breast milk begins to dwindle in quantity or soon after the protrusion of the two first teeth (which usually happens by the ninth month), the baby needs more food than breast milk and the mother should begin to wean her child (that is to say, to educate the child's digestive organs to deal with food materials other than breast milk) very gradually, substituting for breast milk cow's milk modified by dilution with water (to reduce the protein figure within the digestive capacity of the infant) and the addition of milk sugar and cream to the diluted milk so that the mixture approximately corresponds to the percentage composition of breast milk. Modified or "humanised" milk may be prepared in the following manner:—Take ½ pint of cow's milk, 1 ounce of cream (containing 33 per cent. of fat) and 1 ounce of milk sugar and add water to make a total of 1 pint.

The number of breast feeds to be replaced by modified milk in each week and the quantities to be used are given in the following table:—

Number of breast-feeds to be replaced	Time of artificial feeding	Amount of modified milk to be used for each feed
1st Week ... 1 ...	2 p.m.	8 oz.
2nd Week ... 2 ...	10 a.m. and 2 p.m.	8 oz.
3rd Week ... 3 ...	10 a.m. 2 p.m. and 6 p.m.	8 oz.
4th Week ... 4 ...	6 a.m 10 a.m. 2 p.m. and 6 p.m.	8 oz.
5th Week ... 5 ...	6 a.m. 10 a.m. 2 p.m. 6 p.m. and 10 p.m.	8 oz.

The above table is intended only as a guide. The amount of milk required in twenty-four hours depends, in fact, on the infant's age, weight and digestive powers and should be varied to suit individual requirements. After weaning, the child's stomach is gradually accustomed to unmodified milk. As he begins to chew properly, other foods (*e.g.*, well-cooked cereals, eggs, etc.) are added to his diet, in small quantities at first, so as to avoid digestive troubles, until, with few exceptions, he is having the ordinary food of the family, but milk must still be his chief food.

Artificial Feeding of Infants.—When the mother is unable to suckle her baby through some physical abnormal quality, or if she is dead, the baby is entirely dependent upon artificial food which should be as nearly as possible like its mother's milk. Even when the mother has an insufficient secretion of milk, this is of priceless value to the baby and should be supplemented by other foods. In artificially feeding the baby, it is the custom in civilised communities to use cow's milk, and milk containing 3 to 3·5 per cent. of fat is recommended as most generally suited for infant feeding, since large amounts of fat tend to interfere with digestion and to cause fat intolerance. Goat's milk and ass's milk are even more suitable than cow's milk for the nourishment of the baby and should be used whenever cow's milk disagrees with the baby. It is, therefore, important to know the main differences in the composition of milk from different sources:—

AVERAGE COMPOSITION OF MILK FROM DIFFERENT SOURCES

MILK	Parts per 100 parts of Milk					
	Water	Proteins		Fats	Carbo-hydrates (milk-sugar)	Salts
		Casein (approx.)	Albumin (approx.)			
Human ...	87·6	0·6	0·6	3·7	7·2	0·3
Ass's ...	89·6	0·7	1·6	1·6	6·0	0·5
Goat's ...	86·3	2·4	1·2	4·0	5·3	0·8
Cow's ...	87·6	2·8	0·5	3·6	4·8	0·7
Buffalo's ...	82·3	4·3	0·5	7·7	4·4	0·8

It should be remembered that in the process of digestion of milk, the casein is curdled by the gastric juice in the stomach, whilst the albumin remains dissolved in the water. The albumin is, therefore, more easily digested than casein. When breast milk enters the stomach of the infant, the curd formed is a loose flocculent mass which is easily digested and assimilated. Ass's milk also produces very fine curds which are as easily digested as breast milk. Goat's milk also forms a light curd which is capable of easy digestion. Cow's milk coagulates in dense curds which are digested with difficulty by an infant. In order that cow's milk may be adapted to the needs of the growing baby, it is necessary to modify it (in the manner described on page 111) so as to make it as much like breast milk as possible. It must be realised that the so-called "humanised" milk can never be the same as human milk in its qualities, for the essential differences between the two types of proteins and the fats remain. Many babies, however, thrive on the modified cow's milk, but some cannot digest it on account of the nature of the curds formed in the stomach. If 2 grains of sodium citrate are dissolved per ounce of milk, the curd produced in the stomach is looser and more easily digested. It is sometimes necessary to partially pre-digest the casein contained in the milk-mixture (by employing liquor pancreaticus and sodium bicarbonate) so as to avoid too great a strain on the delicate digestive organs, especially during the first fortnight after birth. If the baby digests the modified milk, the strength of the milk is gradually increased till it is accustomed to digest whole milk. In the following table the requirements of normal babies for the twenty-four hours and at each feeding are given :—

Age of Baby	Normal weight of baby	Number of feedings	Total quantities in 24 hours
1 month	8½ lbs.	6	18 oz.
2 months	10¼ "	6	21 "
3 "	12 "	6	24 "
4 "	13½ "	6	27 "
5 "	14¾ "	5	30 "
6 "	15¾ "	5	32½ "
7 "	16½ "	5	35 "
8 "	17¼ "	5	37½ "
9 "	18 "	5	40 "

It must be remembered that it is impossible to provide one form of diet suitable for all babies since they vary greatly in weight and digestive capacity. Modification will be necessary to suit the individual and the diet must be made to agree with the child. Dietaries must include adequate amounts of water and provision must be made for an ample supply of vitamins C and D as in the case of breast-fed babies. The artificial feeding of infants will best be guided by a physician, and in every case of artificial feeding, the child should be seen once a month by him.

Sometimes patent foods are used for infant feeding. They are by no means essential for the rearing of normal infants, but are useful in case of ill-health or the failure of ordinary methods of feeding. The ability to use these foods satisfactorily depends upon a knowledge of their character and composition and the requirements of the individual, and expert advice should always be obtained as to a suitable food if it is at all necessary. It must be remembered that, as these foods are more or less altered in the process of preparation, they are deficient in certain inherent qualities of fresh foods, notably enzymes and vitamins. Three main classes of dried patent foods may be distinguished :—

(1) Foods made mainly or chiefly from dried cow's milk.—It is interesting to note that dried milk is more easily digested than fresh milk, for in the process of drying the casein seems to undergo some physical alteration which prevents it from forming a dense clot. Certain delicate infants, unable to digest fresh cow's milk, may be found to thrive on some form of milk powder.

(2) Foods consisting of a mixture of cow's milk, wheat flour and barley malt, the starch of the cereal grains having been wholly converted into soluble and easily digestible substances (*e.g.*, maltose and dextrin) in the process of manufacture.

(3) Foods composed of wheat flour and pancreatic enzymes so that, if the food is carefully prepared according to directions, most of the starch of wheat is converted into soluble forms (*e.g.*, maltose).

The composition of some of the commonly used varieties is given below :—

Patent Foods	Parts per 100 parts *			
	Proteins	Fats	Carbohydrates	Salts
"Cow and Gate" Milk Food [1] (full cream) :—				
Powder	24·6	26·6	38·5	6·0
Liquid (reconstituted by dissolving 1 part of the powder in 7 parts of hot water).	3·0	3·3	4·8	0·75
Sunshine Glaxo [2] :—				
Powder	24·5	20·0	46·0	5·5
Liquid (reconstituted by dissolving 1 part of the powder in 7 parts of hot water).	3·1	2·5	5·8	0·70
"Horlick's Malted Milk" [3] ...	16·3	8·8	68·0	3·9
"Benger's Food" [4]	10·4	1·1	76·2	1·0

---

* Balance of weight is made up by water. The analyses given are approximately those quoted by the manufacturers themselves.

[1] This is dried cow's milk.

[2] This is a humanised milk food reinforced with vitamin D and a salt of iron.

[3] In its preparation malted barley is ground and mixed with wheat meal and the mixture is steeped in water at about 60°C until the whole of the starch of barley and wheat is converted into dextrin and maltose by the action of diastase. The insoluble husk is next removed and the

Sometimes infants, especially twins and prematurely born babies and those artificially fed, suffer from nutritional anaemia due to a deficiency of available iron. The most important feature of this form of anaemia is susceptibility to infections, particularly a liability to colds, otorrhoea, bronchitis and enteritis, and a tendency for the infection to become chronic. It can be prevented or cured by the administration of iron ammonium citrate to infants, or the feeding of infants with milk to which iron in an appropriate form has been added.[1]

Medical advice should always be sought in devising the diet when the infant does not thrive or suffers from digestive troubles.

DIET OF CHILDREN AND ADOLESCENTS

Growing children must receive an adequate supply of nutriment for a normal rate of growth and

---

dissolved substances are mixed with cow's milk and the mixture evaporated to dryness.

[4] It is a preparation of wheat flour and pancreatic extract (containing the enzymes amylase and trypsin). When it is mixed with fresh cow's milk and properly prepared by heating according to directions, most of the starch of the flour is converted into soluble forms (*e.g.*, maltose) by amylase and the proteins of flour and those of milk used in its preparation are also partially digested by trypsin. Thus, infants as well as invalids and persons whose digestive powers have become weakened through illness or advancing age, and who are, therefore, unable to digest milk, can take this mixture satisfactorily.

[1] "Nutrition"—Circular No. 1290 of the British Ministry of Health, 1932.

development, both physically and mentally, and if they are getting an adequate diet, they gradually increase in height and weight as they grow up. The following table gives the average height and weight of growing children at different ages[1] :—

Age (in years)	Boys		Girls	
	Height (inches)	Weight (pounds)	Height (inches)	Weight (pounds)
2	37	32	37	32
3	40	36	40	35
4	43	42	43	41
5	45	45	44	42
6	46	48	45	45
7	48	53	47	50
8	50	59	50	56
9	52	65	52	63
10	54	71	54	71
11	56	78	56	81
12	58	87	58	94
13	60	98	60	104
14	63	103	62	110
15	65	114	63	114
16	67	122	64	117
17	68	126	64	118
18	69	129	64	122

The height and weight of children at a particular age are influenced by many circumstances, such as the physique of the parents, the climate of the country, etc. What is most important is a steady, regular gain in height and weight as the child grows up. It must also be remembered that an increase in height and weight is not the only index of nutritional welfare; a well-fed child also exhibits improvements in alertness, in general tone, in brightness of eye and in the glossiness of skin.

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[1] Ref.—(1) " The Runabouts (children from 2 to 6 years) in the House of Health "—prepared by the American Child Health Association; (2) " Food and Health "—H. C. Sherman.

The energy requirements of children of different ages are commonly assessed as fractions of those of the adults as shown on page 43. In addition to seeing that the total Calories are adequate for the needs of the child, consideration should be given to the choice of foods to meet other nutritional needs. It must be remembered that there is a greater need for good nutritional materials (*e.g.*, good proteins, mineral salts and vitamins) during infancy, childhood and adolescence than for the maintenance of a fully grown person, and damage inflicted during the growing periods by defective diets cannot be subsequently repaired. In fact, much chronic ill-health in later life may have its origin in defective feeding in the early years of life. An abundant supply of milk is an essential item in the diet of children. As foods rich in fats tend to delay digestion, they should be included in the diet only in moderation. The deficiency of vitamins A and D in the diet of children may be made good by the administration of a tea-spoonful of cod liver oil daily. Regular sun-baths also ensure the production of vitamin D in the body. One may be guided by the following suggestions in the feeding of children :—

Class of Food	Diet of children, aged :—						
	1 & 2 years	2 & 3 years	4 & 5 years	6 & 7 years	8 & 9 years	10 & 11 years	12 & 13 years
	Amount (ounces)	Amount (ounces)	Amount (ounces)	Amount (ounces)	Amount (ounces)	Amount (ounces)	Amount (ounces)
Rice	1	2	4	6	8	10	12
Dals	...	½	½	1	1	1	2
Green leafy vegetables (calculated as spinach).	1	1	2	2	3	4	4
Milk (whole) ...	30	35	35	35	35	35	35
Fish	1*	1*	1*	1†	2†	4†	4†
Meat	...	...	...				
Egg ‡	...	...	...	1	1	2	2
Sugar or Gur ...	¼	¼	¼	¼	½	½	½
Vegetable oil, ghee or butter.	¼	¼	½	½	½	½	¾
Fresh fruits of the season ...	(To yield adequate amounts of vitamin C).						

DIET OF MIDDLE-AGED AND ELDERLY PEOPLE

The diet may be arranged in the manner shown in the case of adults, but the following points should be remembered :—

---

* Some portion of fish may be replaced by meat or egg.

† Either fish or meat may be used.

‡ The edible portions of a duck's and a hen's egg average about 60 and 48 grammes respectively.

In middle age, the slowing both of basal metabolism and muscular activity results in a markedly diminished energy output. A reduction in the amount of food (as measured in Calories) of a middle-aged or elderly person (male or female) is, therefore, necessary. But the need for mineral elements and vitamins is not diminished. It should be kept in mind that fresh fruits and green vegetables provide bulk and help to satisfy the appetite without overloading the system with more energy-giving foods than it can digest. As the digestive powers are already enfeebled in middle-age and in later life, the foods selected should be nutritious and at the same time easily assimilable. Very old persons, like the very young ones, are not equipped to break up hard foods with their teeth and must, therefore, depend upon liquid foods, or upon soft and easily disintegrated food mixtures which are not dependent upon thorough mastication for good utilization. In fact, old age may be considered as a second childhood and should be dieted accordingly.

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ERRATA AND THEIR CORRECTIONS

PAGE	LINE	FOR	PLEASE READ
4	2	"essential amino acids is, when taken by itself, is a"	"essential amino acids is, when taken by itself, a"
26	21	"the of mother"	"of the mother"
36	20	"Dialim"	"Dalim"
	22	"Sheddock"	"Shaddock"
41	4	"3 hours' sleep (basal metabolism)"	"8 hours' sleep (basal metabolism)"
78	4	"of the diseases and excrete these organisms"	"of the diseases and excretes these organisms"
81	14	"MEALLIC CONTAMINATION"	"METALLIC CONTAMINATION"
89	10	"We lack at present the precise knowledge of the amonnt of carotene"	"We lack at present the precise knowledge of the amount of carotene"
105	12	"and cows at a little cost and are"	"and cows at a little cost and they are"